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EVERYTHING PNEUMATIC.

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TYPICAL POWER DRIVES ON THE NEW YORK BARGE CANAL*

The traveler of the present, journeying through the valley of the lower Mohawk, has doubtless observed that at numerous points along the river extensive operations of an engineering character are being carried on, and he is told that the canalization of the Mohawk river, a leading feature of the 2,000 ton barge canal project, is now in full swing along the line.

Huge dams are planned to bar the river channel, and these structures being the major feature in the cost and difficulty of building the waterway, it becomes important that their construction should be first under way, not to delay the completion of the project in its entirety.

The cost of the various contractor's plants to build these structures amounts to no mean figure. Local conditions vary in nearly every instance, and to meet these conditions requires careful study on the part of the contractor and his engineers, in order to assemble the most economical and efficient plant with a minimum of expenditure in time and cost.

Three localities are here selected, at each of which the work and the conditions are different from the others, and the plant at each point varies in important particulars, though each is in some respects typical of its kind. These three plants are embraced within a single contract, that of the Acme Engineering and Contracting Company, and, therefore, under the ultimate supervision of a single set of officials.

*Condensed from *Barge Canal Bulletin.*

An attempt has been made to have all apparatus conform as near as possible to some adopted standard, thus forming an equipment which may be used collectively or individually with the most economical results.

In order to maintain all apparatus in good condition, and to make all repairs as quickly and cheaply as possible, an efficient and complete machine shop was installed at a central point at Lock No. 7. Not only all the repair work from the several branches of the contract is done at this shop, as well as many small parts of derricks, etc., are manufactured and sent out to the various jobs, and it is seldom necessary to call upon an outside shop to do any of this work.

Three distinct systems of power development and distribution are in use at these points:

First, direct steam drive, furnished to the engines from small individual boilers located at various points on the work. This is the system ordinarily used on small contracts and is in operation at Dam No. 11, Lock No. 15, at Fort Plain.

Second, compressed air drive, furnished from a central steam driven compressor plant, located at a convenient point on the work. This plant is designed with the idea of producing steam to drive the compressors at the lowest possible cost, and so to overcome the loss of efficiency in the compressor and the loss in transmission to the engine. This system is in use at Dam No. 3, Lock No. 7, located a mile above Vischers Ferry.

Third, compressed air drive combined with electric power. The compressed air is furnished from a central compressor plant driven

by a belt from an electric motor, and is used for operating hoists, drills, etc. Electric motors are used direct at various points on the work for driving pumps, stone crusher, tools in carpenter shop, etc. This system is in operation at Dam No. 2, known as the Crescent dam.

Each system has been entirely satisfactory under existing conditions, and at the same time the diversity of system has furnished an excellent opportunity to compare the strong and the weak points of each and determine the peculiar conditions to which it is especially adapted.

At Fort Plain, the most western of the three points, steam is used exclusively as previously stated.

The plant at Vischer's Ferry is especially interesting because it is at a central point of the contract as a whole. All the engines and pumps at this place are driven by compressed air, with the exception of one derrick. The compressor plant consists of two Ingersoll-Rand 24-in. steam, 26¼ and 16¼ air by 24-in. stroke straight line, two stage, class A C compressors driven by steam furnished by five 100 H. P. Erie City boilers of the portable return tubular type. These boilers are all connected into an 8-inch steam header, from which pipes lead to each compressor and to a small direct-connected electric generator. The exhaust steam from the compressors passes through an Erie City counter-current feed water heater. This heats the feed water nearly to the boiling point before it enters the boilers. The plant is so located that coal cars can be pushed upon a trestle in front of the boilers and unloaded very easily.

The free air is drawn into the low pressure cylinders from a screened box outside the building through 9-inch pipes. After being compressed in the low pressure cylinder to about 30 lbs. it passes through the intercooler to the high pressure cylinder. This raises the pressure to 100 lbs. and the air then passes through 6-in. pipes to the 5 ft. by 18 ft. vertical receiver located just outside the building. At this point the distributing system begins. The air leaves the storage in an 8-inch pipe which branches into two 6-inch pipes, and these in turn branch into two 4-inch pipes. Each 4-inch pipe leads to a separate part of the work and each is provided with a valve, so that in case of an accident to any part of the system it can be cut off and the other parts carried on without interference.

One line is taken to the machine shop, which is near, to run the 20 H. P. engine driving the shop, also the 300 lb. steam hammer and the forges. A second line is taken along the side of the lock and provided with taps about every 40 feet. This line furnishes air for operating a 9 by 10-in. Lidgerwood hoist on a traveling derrick with an independent swinging engine, a 5-in. plunger pump and a 12-in. direct-connected centrifugal pump, also drills, etc., which are used in the excavation and in the placing of concrete in the lock. A third 4-in. line supplies the work in the main dam in a similar manner and terminates in a receiver on the island.

From the mixer on the island a railway runs along the cribwork of the upper coffer dam to the south side, with the usual outfit of locomotives and cars. Below the dam and railway run two other parallel tracks. Upon these, mounted upon suitable trucks, are two revolving derricks with 75 ft. swinging beams, similar to the derrick located on the work at the lock. The stiff leg of each derrick is supported upon a truck running upon one line of the railway, while the derrick itself rests upon the other line. These derricks use the air in 9-in. by 10-in. Lidgerwood engines.

A fourth 4-in. line runs directly from the receiver at the compressor house to the 5 ft. by 18 ft. receiver on the island. From this receiver another distributing system is started, consisting of a 3-inch line to each of the 12-in. by 15-in. cable engines and a 10-in. by 12-in. three drum hoist and a small swinging engine. These cables have a span of about one thousand feet with towers on the island 100 ft. high. Both have a capacity of ten tons and one is equipped with an aerial dumping device. The Hains concrete mixer is located at this point and material is fed to the mixer by a guy derrick operated by another 10-in. by 12-in. three drum Lidgerwood hoist.

It has been found necessary to reheat the compressed air at a point near the engines, except in very warm and dry weather, this reheating also greatly increasing its efficiency. The heating is accomplished by means of coils of pipe enclosed in a rectangular iron box supported above a set of grates upon which a small steady coal fire may be kept. All the re-

heaters are made at the company's machine shop at Lock No. 7.

The third location on the contract is still farther down the Mohawk, just below the entrance to the land line leading to the flight of locks at Waterford. Near the work here was found an outcrop of massive, close-grained rock which resembles, if it is not, trap. A quarry has been opened here, not far from the center of the work, and from this will be taken stone for building the dam, which otherwise must have been imported from elsewhere, while the spalls and fragments will be excellent for concrete. An Acme crusher has been erected and all the quarry equipment of drills and hoists is also operated from the general power system.

The plant here (Dam 2, Crescent) is a combination of steam, compressed air and electric drive. The hoists, drills, etc., are driven by compressed air, while small motors are used at several points on the work for operating pumps, stone crusher, tools at carpenter shop, etc.

Electric current is purchased from the Hudson River Electric Power Company and is supplied at 30,000 volts to transformers which reduce the voltage to 600. Various lines are taken from the transformers for use for motors and lights at all points of the work. Heavy wires are carried across the short distance between the transformer house and the compressor building to supply the 250 H. P., 600 volt, three phase induction motor used for driving the compressor. This compressor is an Ingersoll-Rand, class I C, belt driven machine with air cylinders 25¼ and 16¼ by 16 in. stroke having a capacity of 1,205 cu. ft. of free air per minute. The air passes from the compressor to the horizontal receiver outside through a 6-in. pipe. There are three distinct lines running from the receiver to the different parts of the work. One line, about 1000 ft. long, furnishes air for running the hoists and drills at the quarry. Another, about 1,500 ft. long, furnishes air for running two 10-in. by 12-in. three drum hoisting engines at the canal. Still another line supplies air for the work in the river.

The total equipment, then, driven from the air compressor consists of two 10-in. by 12-in. three drum hoisting engines used for unloading material and feeding the mixer, one traveling derrick used in excavating and placing concrete, two derricks in the quarry, three or four small pumps, and from one to eight rock drills. A McMyler traveling crane is used for excavating and placing concrete in the main dam, this machine having its own boiler.

The equipment of this work as a whole is an application of electric drive to the ordinary steam machinery. This is accomplished by using the electric power to drive the air compressor and then using the air in the ordinary steam engines.

COMPRESSED AIR VERSUS STEAM IN COAL MINING

By P. P. Glenn*

The most expensive and difficult operation in the production of coal is the process of loosening its solid state, and this is accomplished in three ways. First, by blasting it from the solid as is done in the Connellsville region. Second, by undercutting for blasting. Third, by shearing either in the center or on the rib, and shooting to the shearing. This method is used in many bituminous mines where there is a strong roof, and where the run of mine basis is used. There is, of course, some intermixing of those methods, as in some mines they both undercut and shear in order to protect a tender roof, and to get a large proportion of lump coal; for where the coal is both undercut and sheared on one rib it can be brought down with a very slight charge of powder. In some cases no powder at all is used, and the coal wedged down after being undercut and sheared.

Many machines have been constructed to undercut and shear coal, and they are now so perfect as to meet the various requirements found in the different coal fields that it may safely be said that compressed air coal cutting machines will in the future do the greater part of coal getting. The most successful of these machines may be divided into two classes, those which act percussively and cut with a single large chisel, and those which cut with a series of steel teeth. The second class is subdivided into four classes, one of which may cut out a larger cylinder of coal, and which is used almost exclusively for driving headings. One of those machines, 'the Stanley header,' can cut out a cylinder of bituminous coal four feet in diameter and five feet in length in 15

*Scottdale, Pa., Mining Institute.

minutes, and after making the necessary allowances for removals, a rate of advance equal to 75 feet per shift of 10 hours is accomplished. When it is necessary to drive wide entries, two machines may be worked, side by side, thus driving two parallel entries which nearly intersect each other. The thin pillar left between them can easily be cut with a pick. If the coal could be removed as quickly as the cutting is done, the machine could advance an entry 12 feet wide, 25 feet in 10 hours. As coal varies so much in hardness, and in the amount of impurities it contains, it is possible to give only an approximation of the cost of driving entry with the Stanley Header, which is about 25 cents per linear foot when a single cylinder four feet in diameter is cut out, operated by compressed air.

Compressed air is much used as a motive power in place of steam for driving engines, pumping, and ventilating purposes, also for undercutting machinery and drilling. The principal of an air compressor depends upon the fact that when any given volume of air is compressed in a certain ratio, the absolute pressure or tension of the air is increased in the same ratio, in which the volume is decreased when the temperature remains the same. The compression of air, however, causes a rise of temperature in the air compressed, which increases the pressure in a greater ratio than that just given. In practice this increase of temperature is a detriment owing to the late cooling, and consequent loss of pressure in the transmission of the air to the point where it is to be used. Air compressors are designed therefore to maintain the temperature as nearly constant as possible during the compression.

The power is applied to an engine in the use of compressed air in the same manner as in the use of steam; steam engines are often operated as an air engine with but a slight arrangement of the valves. The advantage of compressed air over steam consists in the ease with which the power is transmitted to the working face. The losses due to the condensation of steam and the radiation of heat in a long pipe line are avoided where compressed air is used. In case of a break occurring in the pipe line, there is no danger of scalding workmen or animals, and the air exhausted from the cylinders of the machines on the roads or at the working face, is a benefit instead of being a hindrance, as is the case with exhaust steam. In the use of compressed air the power loss in transmission and compression can be retarded, wholly or in a part, by re-heating the air. In mine haulage compressed air motors possess the advantage over steam locomotives in that they require no fire, do not contaminate the air of the mine by gases of combustion, or run any risk of igniting the mine gases. In haulage the required pressures are necessarily high, ranging from 500 to 1,000 pounds pressure gauge. In this work compound compressors are better adapted, because where air is compressed in two, three, or four stages, a high pressure can be attained with a comparatively small range of temperature in the compressor cylinder, and the result is a greater saving of power.

Drilling and cutting machines, and pumps are generally operated under pressure ranging from 60 to 100 pounds per square inch. Mine motors are designed for high pressure up to 150 pounds per square inch at the throttle, the tank pressure varying from 600 to 800 pounds, while a pipe-line pressure varying from 600 to 1,000 pounds per square inch is commonly used in main haulages. It is good practice to provide a pipe line of sufficient size to pass the required volume of air at a velocity varying from 20 to 50 feet per second, and not to exceed 50 feet per second for good results.

LARGE AIR COMPRESSOR FOR SOUTH AFRICA

The half tone and several cuts here reproduced from *The Engineer,* London, and the description condensed from the same source, tell us of a large air compressor which has recently been shipped to Johannesburg by Alley and MacLellan, Limited, of Glasgow. This plant embodies several new features. Its duty is 5000 cubic feet of free air per minute net capacity, corrected for all losses, including heating, compressed to 100 lb. per square inch. There are three cranks arranged 120 deg. apart, over which are placed the trunk air cylinders. The compression is effected in two stages, the upper end of the cylinders being the intake. The final compression is carried out in the annulus formed under the trunk piston.

The motive power is obtained by means of three steam cylinders, one high and two low, 25 in. and 32in. diameter respectively, each of which is arranged tandem over an air cylinder.

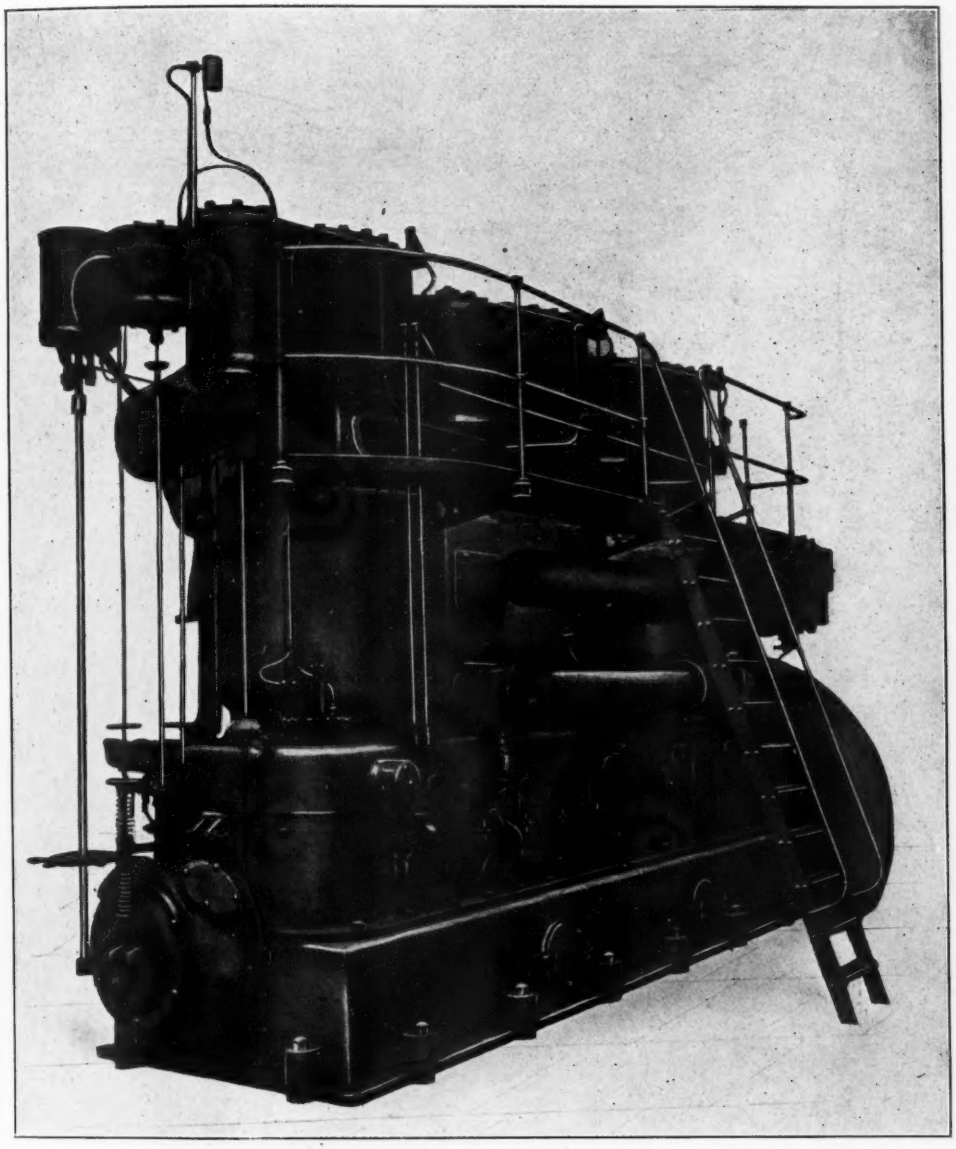


FIG. 1—AIR COMPRESSOR OF 5,000 CUBIC FEET CAPACITY FOR SOUTH AFRICA.

The three air cylinders have all of them the same dimensions. In the larger part they are 37in. in diameter and in the smaller 29½in. The diameter of the piston-rod is 4¼in. The area of the larger part of the cylinder is therefore—allowing for the piston-rod—1061.014 square inches, and of the annulus 391.71 square inches. The stroke of both steam and air cylinders is 16in. The air, after being compressed in the larger part of the cylinder, is delivered to an intercooler, which has a cooling surface of 1000 square feet, before being further compressed in the smaller part. The compressor cylinders and their valves, which are of the piston type, are all heavily water-jacketed. A perspective view of a differential piston and its piston valve is given in Fig. 5.

The compressor is designed to give the

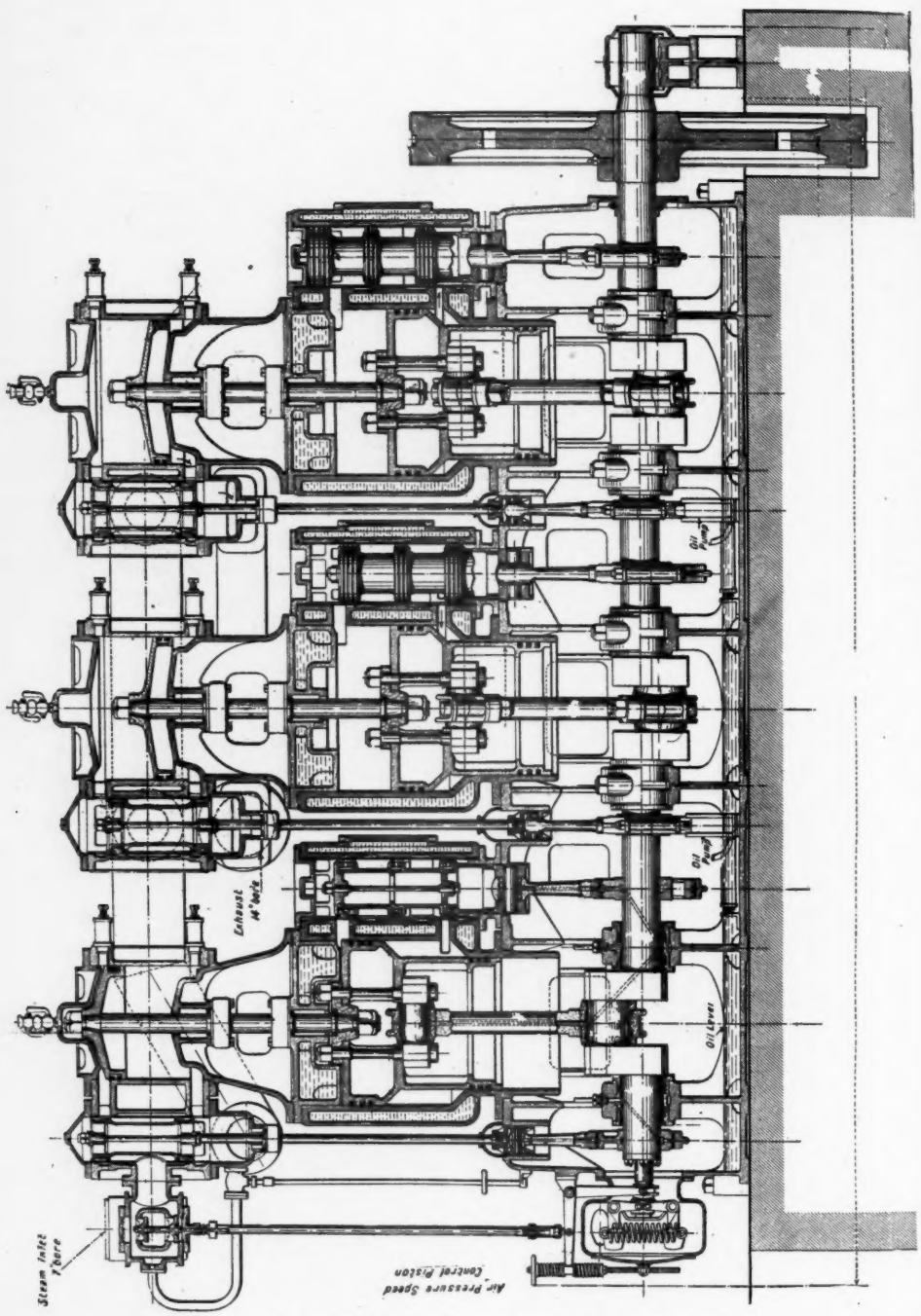


FIG. 11—VERTICAL LONGITUDIANL SECTION OF COVPRFSSOR.

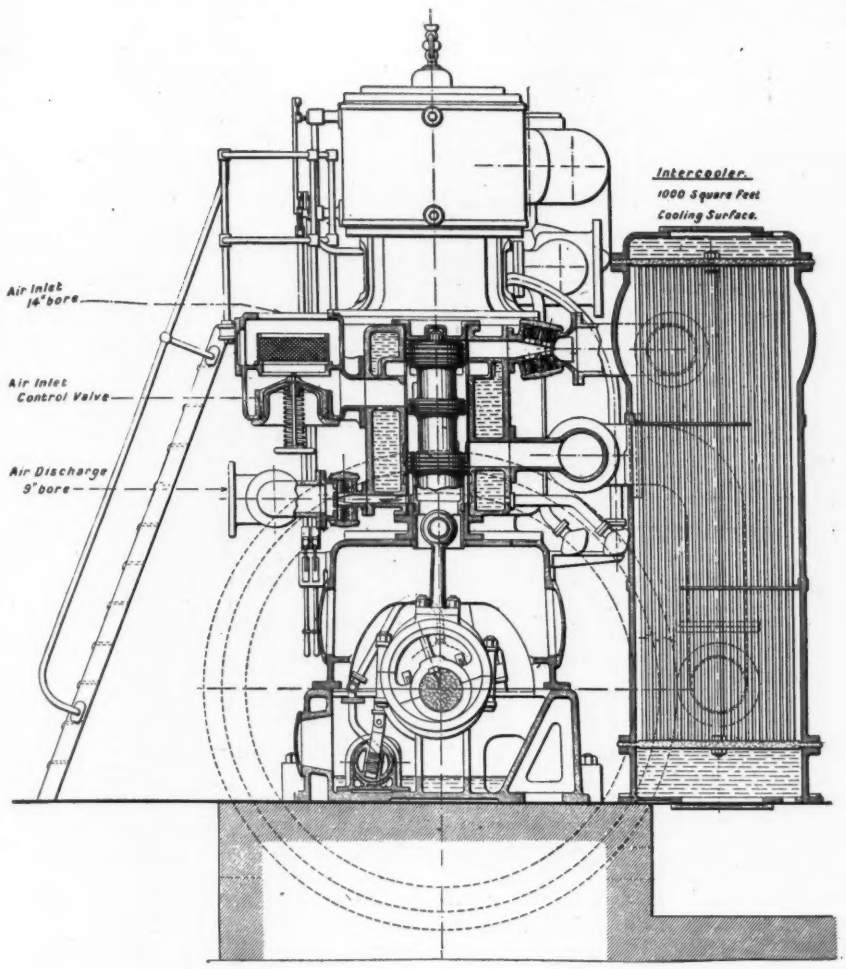


FIG. III—TRANSVERSE SECTION OF COMPRESSOR.

above-mentioned output when supplied with steam at 140 lb. per square inch, and when exhausting into a surface condenser which is capable of maintaining a vacuum within 4in. of the barometric pressure. The designed speed of the engine is 187 revolutions per minute, which means a piston speed of practically 500 ft.

The action of the compressor will be readily understood. During the down-stroke of the piston A, Fig. 2, air from the atmosphere is admitted past the positively operated piston valve D, through the port H to the low-pressure air cylinder B. When the motion of the piston is about to be reversed, the piston valve closes the inlet to the low-pressure cylinder, and when further upward movement has compressed the air the piston valve has moved downwards, permitting the discharge of air over its head and through the low-pressure discharge valve-box to the intercooler. While the piston is thus moving upward, air is drawn from the intercooler past the piston valve into the annular high-pressure cylinder, and the next down-stroke further compresses the air in that cylinder until it is discharged at the working pressure past the piston valve and the discharge valve-box to the storage reservoir. The air is drawn in at the top of the machine, where it is most free from flying grit, and is further purified by passing it through a gauze strainer. The surface area of this strainer is

large, and it can be drawn out and cleansed in a few moments.

The valve gear is simple and solid. The principal part is the piston valve. This, in effect, is exactly the same as the piston valve of a steam engine, but it is timed somewhat differently. It regulates for both high and low-pressure cylinders—(1) the commencement of admission, (2) the termination of admission, and (3) the cessation of the air discharge. The actual discharge of air from each cylinder is controlled by groups of poppet valves, which are made from special steel oil tempered.

To follow the action, take first the low-pressure end. Imagine that the piston A* has moved enough downward to allow the air in the clearance space to expand to atmospheric pressure. The piston valve D at that moment is far enough up to allow air to be drawn from the atmosphere past the edge of the piston valve marked *a* into the low-pressure cylinder B. At the bottom of the piston's stroke the shuts the port H by its edge marked *a*. Shortly afterwards the piston, having moved upwards, compresses the air until finally, the piston valve having at the same time descended, allows the partially compressed air to escape above its cylinder is full of air, and the piston valve edge *b* through a set of poppet valves, seen in the cross section in Fig. 3, to the intercooler. The functions of the high-pressure cylinder are controlled in the same way, excepting that the motion is opposite.

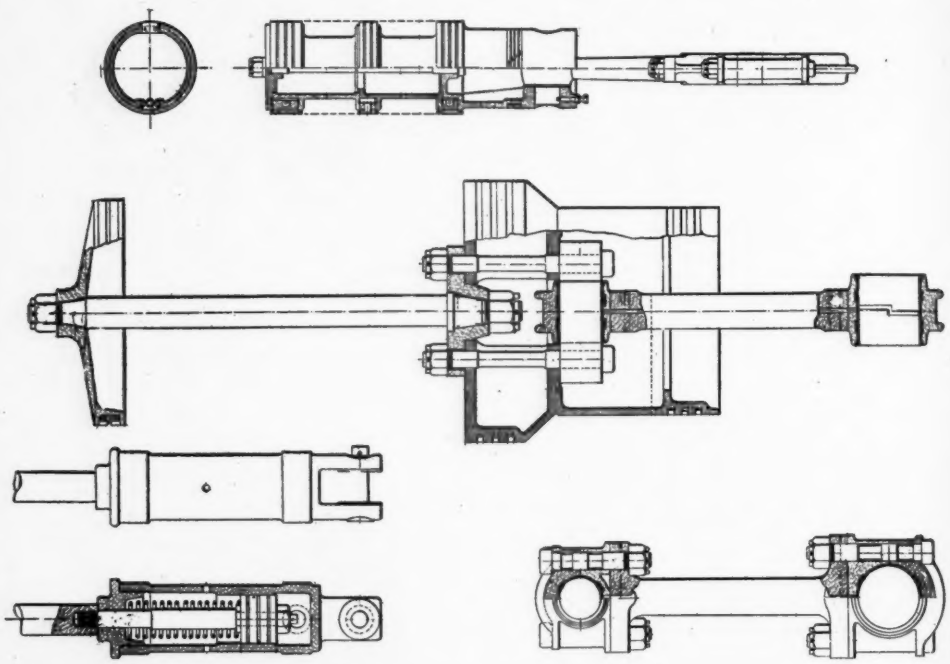


FIG. IV—DETAILS OF COMPRESSOR.

The piston valves have three other functions in addition to the foregoing: First, they ensure that the poppet valves are returned gently on to their seats. Such valves when placed, as is usual, direct on the cylinder, follow the receding piston, above which they work, on to their seats. In this design the poppet valves follow the piston valve, not the main piston; and, as the area of the piston valve is about one-eighth that of the piston, and as its stroke is about one-fourth, the rate at which the valves come on their seats is relatively as the product of these two, or $^1/_{32}$ of the usual rate. Then, too, the blow the valves strike on their seats is as the square of the rate of closing, so that the

*The reference letters were unfortunately not preserved in the reproduction of the cut.—Ed. C. A.

valves under consideration strike their seats with $^1/_{1000}$ part of the impact which would result if they acted without the cushion of the piston valve. The result naturally is that there is considerably less noise and that the valves last a good deal longer; indeed, the makers claim that they are practically everlasting, and after continued running show no appreciable wear on their faces. The low-pressure discharge valve is shown in Fig. 6.

Secondly, the piston valves reduce the clearance losses to a minimum. The clearance volume is only about 4 per cent. Thirdly, as the makers point out, they introduce the air in thick streams, so that the friction of entry is reduced and the cylinders are fully filled at each stroke with cool air.

After the first stage of compression is complete the air passes through the intercooler, and is there cooled before being delivered to

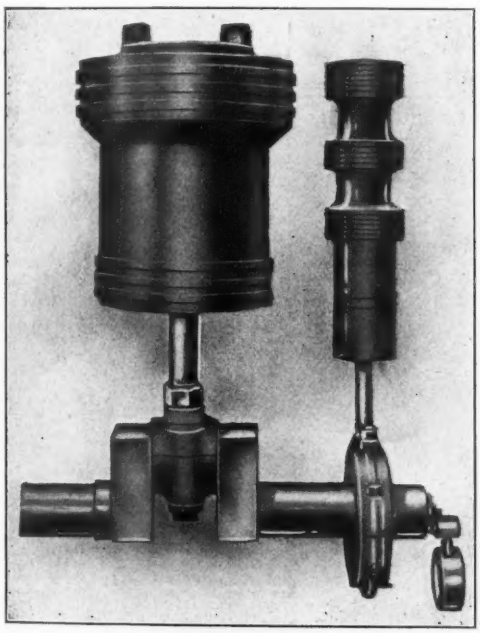


FIG. V—DIFFERENTIAL PISTON AND PISTON VALVE.

the discharging cylinder. The cold cooling water enters the intercooler at the bottom, flows as it is heated along the lower set of tubes to the other end, and then back along the upper set of tubes to the water outlet. The hot air enters at the top and is discharged when cooled at the bottom. The intercooler

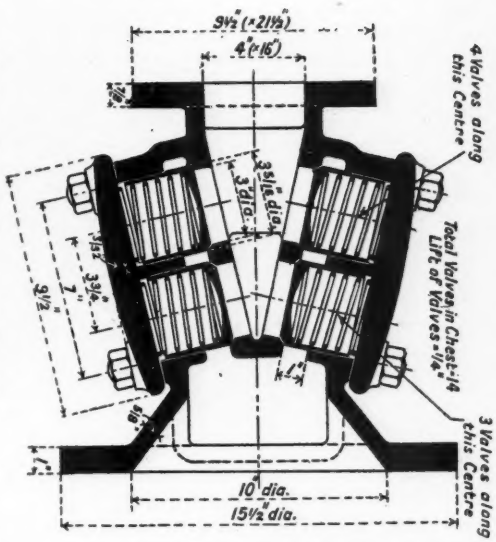


FIG. VI—LOW PRESSURE DISCHARGE VALVES.

works on the counter-current principle, and the air impinges on and is split up by the tubes, so that the cooling surface is utilized to the fullest extent. The circulations of the air and the water are both in the natural directions, so that only heated water and cold air can escape.

The governing of the compressor is carried out automatically. For this purpose an automatic slowing gear has been fitted, which reduces the speed of the plant when the pressure reaches a fixed limit.

The method of oiling is by forced lubrication. Two valveless oil pumps are provided, and these are operated from the low-pressure steam valve eccentrics. They are disposed 120 deg. apart, so that there is a fairly uniform distribution of oil into the lubricating pipe system.

The net shipping weight of the compressor was 60 gross tons, and of the condensing plant 7 tons.

Consul Ralph J. Totten writes from Puerto Plata that there are very few windmills used in Santo Domingo. If Spanish-speaking salesmen could be sent to demonstrate the utility of the windmill in connection with agriculture and stock raising, a demand could be created. Many portions of this country, naturally fertile, suffer from lack of moisture in the dry season. This difficulty could be overcome by windmill and tank irrigation.

COMPRESSION AND TRANSMISSION OF NATURAL GAS

Natural gas as it occurs in the States of the Middle West often emerges at pressures considerably above atmospheric; sometimes several hundred pounds higher. In some cases, however, the pressures are so low as to be insufficient to drive it through by transmission lines except with prohibitive size and cost of pipe. In such cases compressors are employed to increase the pressure and reduce the volume of the gas. These compressing units are of large size and quite naturally the gas itself, in suitable gas engines, is being adopted as the handiest and far the cheapest source of power.

The practical limit for transmission pressures is about 350 pounds, as higher pressures, especially in cold weather cause liquid and even solid deposits of constituents of the gas, and even at pressures considerably lower drainage tanks must be provided along the line.

An interesting plant for this service, which we here illustrate, is that of the Mohican Gas and Oil Company at Howard, Ohio. The gas which is here pushed along comes from a hundred gas wells located within a radius of 35 miles, the pipes leading to the station being from 6 to 10 inches in diameter. The combined supply of gas after compression is transmitted through 16, 12 and 10-inch pipes, reaching as far as 80 miles to Akron, Barberton, Orrville, Millersburg, Wooster and intermediate towns.

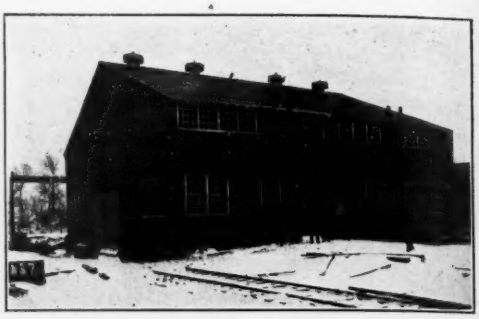


FIG. I—COMPRESSOR HOUSE.

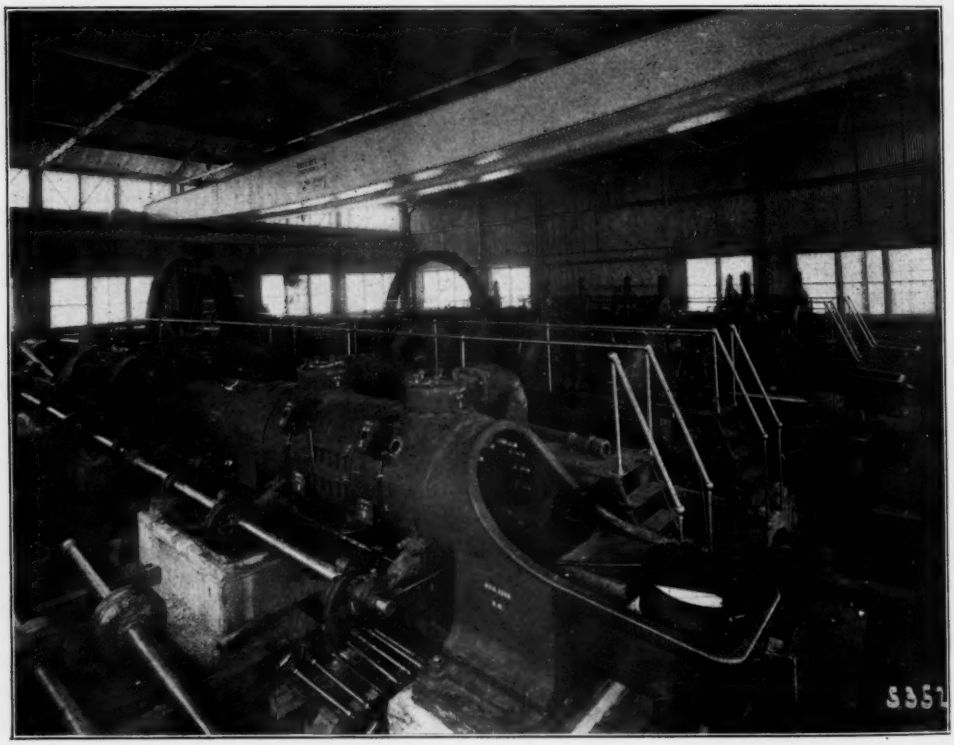


FIG. II—GAS ENGINE END OF COMPRESSOR.

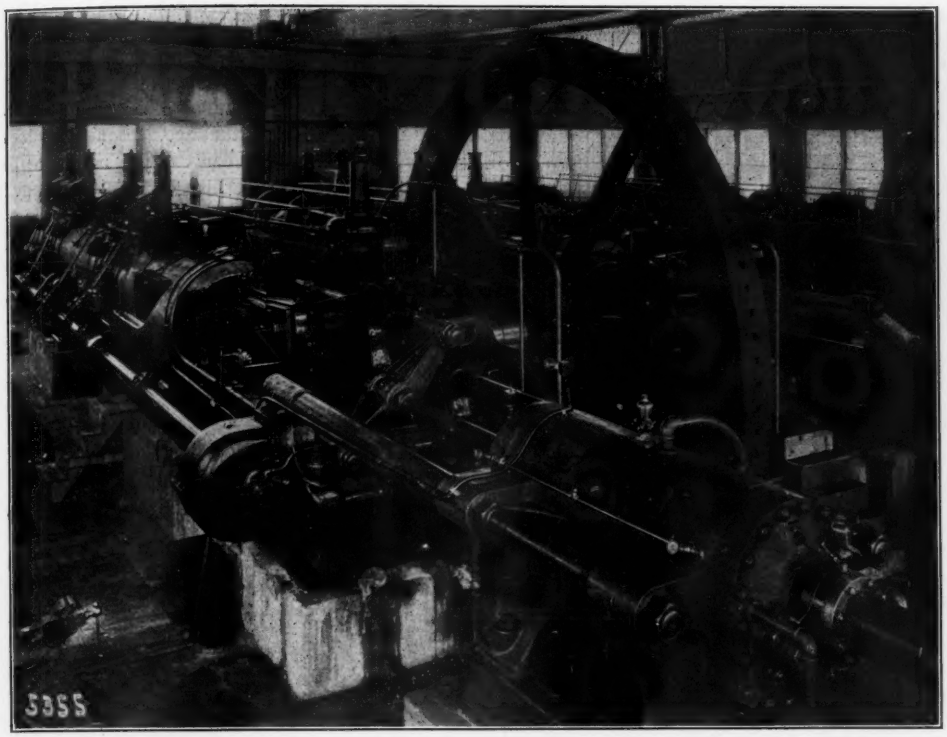


FIG III—COMPSESSOR END.

There are two compressors at this station, both of them gas engines of the Westinghouse horizontal, double-acting, four-cylinder, four-cycle type, giving one impulse in each end of each cylinder every alternate revolution, or four impulses per revolution, the same as with a two cylinder steam engine. Ingersoll Rand, Piston Inlet cylinders comprise the compressing feature of the machines.

Fig. 1 is a view of the outside of the compressor house, chiefly notable for the absence of boilers and stacks and piles of fuel. Fig. 2 shows in the foreground the gas engine end of one of the compressors with the assembling not completed, the fly wheel of the compressor in the background showing it to be running at full speed. The engine cylinders are 23½ in. dia. by 48 in. stroke, giving at the maximum speed of 88 revolutions per minute about 1300 brake horse-power.

Fig. 3 shows the completed compressor end of the other machine. The compressing cylinders are 18 5-8 in. dia., the two cylinders at the above speed giving a piston displacement of 2410 cu. ft. per min. The piston inlet here shows its special adaptability to this line of service, the gas being piped direct through the hollow piston rod into the piston itself and then passing the piston inlet valve into the cylinder. The piston inlet valves in these machines are of the improved or "Hurricane" type. The valve is a single ring of large diameter with a T section, the top or flat of the T seating against the flat face of the piston and closing an open annular groove near the periphery of the piston. No mechanism and no springs are required to operate the valve, it seating itself by its own inertia when the piston starts upon its compressing stroke and opening also by its own inertia to full lift when the return or intake stroke begins. When the valve is open the gas is free to flow into the cylinder at either the inner or the outer edge of the valve thus largely increasing the freedom of inflow. The discharge valves in the compressing cylinders are of the ordinary poppet type with springs, and when they are thrown open the trapping of a small portion of

gas in a pocket of the cap cushions the valve and prevents actual striking. The cylinders are of course water jacketed.

After the compression the gas is passed through a system of piping entirely submerged in water, both to cool the gas and to precipitate the moisture and as much as possible of the liquid and solid deposits of the gas before passing into the long pipe lines.

In connection with the main compressors there is an auxiliary service actuated by two 45 horse power three-cylinder Westinghouse vertical gas engines driving electric generators and centrifugal pumps, the electric current for lighting and also for gas ignition in the cylinders and the water for circulating in the jackets. The auxiliary engines also drive small air compressors compressing air to about 175 pounds which is stored in receivers and used for starting the main engines.

MINES, MINING AND MINING INVESTMENTS

Readers of the COMPRESSED AIR MAGAZINE are interested in all phases of mining. The following is condensed from an admirable article by Richard Linthicum in a recent issue of *The Evening Post,* New York.

Although the prospector rarely receives a large reward for the discoveries he makes, he is the architect of many large fortunes for others. The successful mining camps are his monuments. The thousands of deserted cabins on the mountainsides are the mute records of his blasted hopes. His days of profligate glory vanished when he learned, as a result of the investigations of mining engineers and geologists, that the surface gold deposits of the United States were practically exhausted. Thenceforth the fortunes from successful mining were to come from the depths of the earth, and could only be gained through the work of scientific men and large investments of capital.

Not one in a thousand of present-day prospectors can profit from the discoveries he may make without the assistance of capital, and the capitalist can rarely see anything but a large round hole in the fattest mining-camp doughnut. Nevertheless, the prospector is as necessary to the mining industry now as in the happy-go-lucky days of the past, and although his chances of finding mineral in paying quantities are growing less from year to year, he is the same enthusiastic capitalist in embryo.

HOW MINES ARE DISCOVERED.

The history of mining contains many authentic accounts of the accidental discoveries of rich mines: A mail-carrier between two mining camps, while descending a mountain loses his footing; to save himself, he grasps a projecting rock, tearing it loose and exposing a vein of mineral; a miner pursued by a bear runs across a mineral ledge; the prospector's burro paws in the snow for food, overturns a stone, and behold! there is virgin gold. Discoveries of the sort described are the exceptions and not the rule. Perhaps some of them are not true.

To assume that Chance and Luck are the chief factors in the discovery of mines is a reflection upon the intelligence and the industrious efforts of the simon-pure prospector. He is more or less familiar with the forms in which mineral occurs. He can tell pyrites of iron from gold, but knows that the two minerals are frequently found in combination; he knows the common forms of lead, zinc, and copper, and the natural matrices—silica and lime—for precious and base metals. But, most important of all, he knows the prevailing eruptive rocks of the locality, especially the many forms of porphyry, and he knows, when he finds eruptive rocks on the surface, that mineral is to be found thereabouts.

Hence, when the late spring comes and the snows melt and he goes on a prospecting trip, he searches among the eruptive rocks on the surface for pieces of mineralized rock, commonly called "float." Once he has found "float" on the mountainside, he is then on the trail of the mineral, so to speak, and his next step is to trace it to its source. This is not always an easy task, for the "float" may have been detached from the main body many years before and the original source have been covered by "wash"—earth, gravel, and sedimentary debris. It often happens, however, that the "float" is from a mineral ledge, jutting out of the ground, or from a body of mineral plainly to be seen on the surface—the cropping of the vein or deposit.

MAKING A "LOCATION."

When the prospector has found a vein or deposit, either by tracing the float rock or by

observing mineral stains on a partly eroded cliff, his next task is to determine as well as may be whether it has any value. Having satisfied himself by whatever means concerning the value of the ore, he locates his claim, the dimensions varying in different States, but usually 300x1,500 feet, and begins to prospect it either by driving a tunnel or sinking a shaft, according to the topography of the country.

A tunnel is cheaper and less laborious than a shaft, for the latter requires a windless and much time and work to raise the broken material to the surface. If the tunnel be a "crosscut"—that is, a tunnel to intersect the mineral body at an angle—and must be driven through the country rock, the work of drilling and "breaking ground" can be done much more cheaply and more expeditiously than by the sinking of a shaft vertically through the same kind of rock.

CO-OPERATION OF CAPITAL NECESSARY.

Except in unusual instances, the prospector is no better off after he has discovered and located his "claim" and proved the existence of mineral than he was prior to the discovery, unless he can get the co-operation of capital or sell the property. When the ore is a kind that requires milling, either for the purpose of concentration or separation, the development of ore reserves becomes an absolute necessity for safe operations. Ore that requires treatment in a mill, whatever net profit it may yield as a result of proper concentration or separation, is as valueless to the prospector as the prevailing country rock, so far as his individual operation of the mine is concerned. In other words, a "mine," unless it is one of those exceptions which furnish ore of extraordinary value, is not a mine until it has been systematically developed and sufficient tonnage put in sight to insure regular shipments, or the operation of a milling plant for a period of time at a profit.

This means that before ore can be mined properly and profitably in the average mine there shall be capital outlay for development work. This is a fact and a condition not known or not understood by many men who invest in mining enterprises.

It is more or less apparent therefore that to develop a mine and at the same time insure the safety of the workings, operations are conducted, and perforce must be, with approximately geometrical precision. The size of a block of ore varies with the character of the vein and the wishes of the mine manager, but is usually one hundred feet in length and height.

As an illustration, let it be assumed that the ore is in a vertical fissure vein—not a perpendicular vein, for most verticals have a decided incline, or "dip"—and that the prospect work consists of a tunnel driven upon the vein for 200 or 300 feet. The ore encountered on the tunnel is taken out, of course, as the tunnel is driven, but the ore above and below the tunnel level and beyond the breast of the tunnel remains unexplored. As the dimensions of a tunnel are usually four by six feet, the amount of ore extracted in this exploratory work depends upon the size of the vein, but in no event is it a considerable quantity. The ore above the tunnel level may be developed by putting up "raises" 100 feet apart, and the ore below may be developed by putting down "winzes" 100 feet apart and to a depth of 100 feet, and then connecting them by another tunnel, or technically a "level."

If the discovery tunnel were near the surface, and topographical conditions did not permit lower tunnels to be driven, a prospect of the sort described would be developed by sinking a shaft from the surface, and running "levels" or "drifts" upon the vein every hundred feet, connected by "raises."

READY FOR "STOPING."

Then the various blocks of ore are ready for "stoping," which is the actual mining of the ore. In "stoping," or breaking down the ore, the miner is always beneath the ore body The method of "stoping" depends upon the character of the ore. The soft oxides and carbonates frequently can be stoped with a pick. The sulphides are broken down by drilling and blasting. As the ore is broken down, the "muckers" load it into mine cars, and the "trammers" push the cars out of the tunnel or to the shaft.

The size of a "stope" varies with the size of the ore body. It may be as large as an ordinary room, or simply large enough to enable the miners to do their work.

Methods of operating mines vary in details according to topography, the character of the "ground," that is to say, the formation, whether it be hard or soft, and the physical

characteristics of the ore deposits. For a number of years there has been constant progress in mining methods, which has resulted in great economies. The original method of developing and operating a mine was through a working shaft—the most expensive of all methods, necessitating a large outlay for machinery and power, not only to hoist the ore, but to pump water out and air into the mine. The large costs of shaft operation have been reduced in many cases by the substitution of electrical power for steam, but the outlay for machinery remains the same. The method of shaft operation is rapidly falling into disuse in all localities where topographical conditions do not make it necessary.

MODERN ECONOMICAL METHODS.

The modern economical method of mine operation is to drive a large tunnel—a main working adit—to intersect the vein or veins at an angle and at as great depth as possible, and then operate the ground above the tunnel level. By this method gravity does the work of steam and electricity, and dispenses with much costly machinery. The ore and waste are dropped down to the main adit level, and the former, if the tunnel be properly located, conveyed to a loading platform or to a mill, as required, by a gravity tram.

Not only is the cost of operation reduced to a minimum by this method, but there is also a large saving in original cost of development work, as a tunnel can be driven for one-half the amount required to sink a shaft under the same conditions.

Much thought is given at the present time by mine operators and mining engineers to the problem of economy in timbers. Most mines require timbers, which are a considerable item of expense on account of the necessity of frequently renewing them. I was recently in a group of mines where there were thirty miles of underground workings, a greater portion of which required timber. For purposes of ventilation it was necessary to keep a large part of the workings open, and the timbers were renewed practically every two years.

LOW GRADE VS. HIGH GRADE.

The numerous recent economies in mine operations, together with the improvements in mining tools and machinery and advances in metallurgical science, have made it possible to operate mining properties successfully, which were practically worthless a few years ago. This is particularly true of mines carrying base metals, copper, lead, and zinc. The tendency of mining to-day is all toward the development and operation of base metal properties, because the base metals are found in large quantities and are comparatively permanent in character. In the mining of base metals the percentage of risk is materially reduced as compared with precious metal mining, especially gold properties, by reason of the size and persistency of the base deposits. The most precarious mining is for gold exclusively, and the risk is proportionate, approximately, to the richness of the ore. The "gold mine," however, is the greatest attraction for the investor. Experience shows that the surest and safest mining is in the development and operation of the large deposits of the baser metals reduced practically to a manufacturing enterpirse by economy in mining, handling, and treatment.

Not all gold mines are "bonanza." The largest and most permanent producing gold mines are those in which the ores are of low value, existing in large quantities. The ore in the largest two gold mines in the United States does not average more than $3.50 per ton. Through economies in mining and milling, these properties pay large dividends annually, while hundreds of bonanza gold mines fail comparatively or utterly.

The development and operation of low grade deposits of base minerals have been retarded many years by the presence of zinc blended with the other minerals. Until five or six years ago, zinc was the bane of metaliferous miners. At present it is one of the most sought for minerals, for the reason that advances in metallurgy have made it possible to separate it from the accompanying minerals and thus permit of its separate treatment in smelters.

If investors in mines would take the pains to inform themselves about the most elementary facts concerning the mining and treatment of ores, the nature of the deposits and the methods of extraction, the disasters and losses in mining ventures would be greatly reduced.

THE FIRST COAL CUTTER IN BENGAL

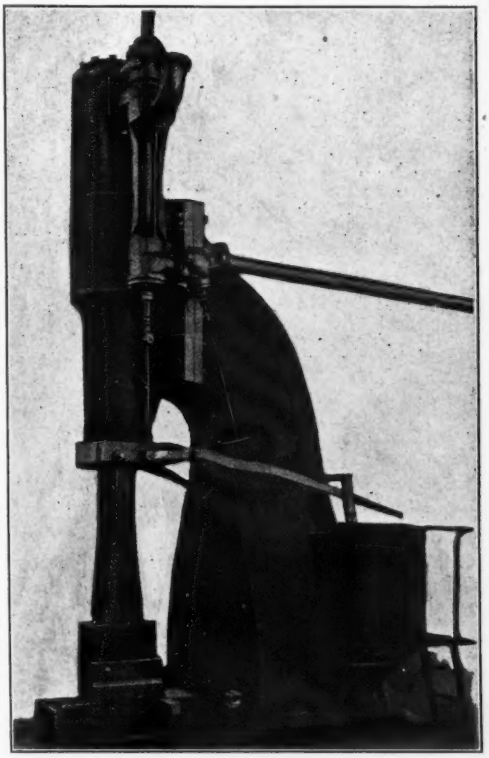
In a paper printed in the Transactions of the Mining and Geological Institute of India, Willis Howarth gives an account of the working of a colliery of the Secteramore Coal Company, Nursamooda, India.

The management decided to try mechanical coal-cutters, so that the output would be steadier and not so spasmodic as is the case when native labour is employed. A compressed air plant has been put down at No. 3 pit for generating power to run one machine and the pumps. The steam cylinders are 24 in. in diameter with 24-in. air cylinders, and were supplied by Messrs. Walker Bros., Wigan. The plant will only be single for a time, but the duplication can be brought out any time it may be thought necessary. The receiver at the surface is a 30 by 7 ft. Lancashire boiler, and the air is being carried down the shaft in 6-in. pipes, specially made with patent packing for the joints. The receiver underground is an 11-ft. cylinder 3 ft. 6 in. in diameter. It is placed near to the face, and from it the air is led by 2-in. pipes to the coal-cutter, which requires about 700 cubic feet per minute at 45 lbs. pressure.

The cutter was supplied by the Diamond Coal-cutter Company, Limited, Wakefield, this machine being the first of its kind in Bengal; cylinders 8 in., stroke 8½ in., cutting 5 ft. 6 in. under the coal. With this machine it is expected that the output will be increased by 4,000 tons monthly in No. 3 pit. On the duplication of this plant it is estimated to generate 3,500 cubic feet of free air per minute, at a pressure of 60 lbs. at the receiver, sufficient to work four cutters.

A STEAM HAMMER CONVERTED TO AIR

The half-tone here reproduced from *The Engineer*, London, shows a steam hammer belonging to a well known firm of British shipbuilders which has recently been altered to enable it to work with compressed air instead of steam. The stand for the operator indicates that the hammer is not a small one. The weight of the falling parts is 5,500 and the limit of stroke is 42 inches. There are operating levers on both sides of the hammer. The change from steam to air necessitated the attaching of compound air cylinders, complete with tup, valve chest and operating gear, to the existing steam hammer standard without alteration of base plate or anvil block. There are two cylinders one above the other, the lower serving as a guide. The upper end of the tup, working in the top cylinder has the function of a differential piston. High pressure air raises the tup, and this air on being exhausted is expanded on the top side of the piston, giving sufficient force for ordinary blows. If a very heavy or stamping blow is required the operator can apply the full air pressure on the top of the piston, the re-expanded air serving as part of the charge and the augmented pressure being made up from the air supply. In regular running, owing to the difference in the areas of the annular ring below and of the entire piston surface above, the air first used to raise the tup is expanded to nearly four times its initial volume and is finally expelled at about atmospheric pressure by the raising of the tup again.



LARGE STEAM HAMMER CONVERTED TO AIR.

AIR DESTROYS WOOD

Piles driven by the hut dwellers of the Baltic, centuries ago, are as sound to-day as when first placed. The wooden coffins in which the Egyptians buried their dead are still preserved in perfect condition, after thousands of years of service.

The longevity of timber under these two extremes of climate and moisture conditions has naturally made people ask, what causes wood decay? The answer is, fungi and bacteria—low forms of plant life which live in the wood and draw their nourishment from it. The little organisms are so small that a microscope is required to see them, yet their work results in the destruction of billions of feet of timber each year.

In stuyding the means of preventing decay wood-preserving experts have learned many things about the obnoxious fungi which sap the life of timber. The small organisms can grow either in light or in total darkness; but all of them require requisite amounts of air, food, moisture and heat. If one or more of these essential requirements is lacking, they cannot live, and the decay of timber will not take place. Wood constantly submerged in water never rots, simply because there is an insufficient supply of air. This condition accounts for the soundness of the old Baltic piles. On the other hand, if wood can be kept air-dry it will not decay, because there will then be too little moisture. The timber used by the Egyptians will last indefinitely so long as it is bone-dry.

There are a great many cases, however, where it is impossible to keep wood submerged in water, or in an absolutely air-dry condition. In fact, a large percentage of the timber used is exposed to the weather, and is subjected to decay simply because it contains enough air and enough water for the decomposing organisms to get a foothold. Decay is most serious where the atmosphere is warm and damp, because these conditions are most favorable for its development. In the coal mines of Pennsylvania timber decays in two or three years, because the temperature is warm and constant and the air is damp; and in the south the warm, humid atmosphere often causes the timber to rapidly decompose.

Decay may be prevented by two general methods, by treating the wood with antiseptics, thus poisoning the food supply of the organisms which cause decay, and by treating it with oils, which render it waterproof. A combination of these two methods is most commonly used, as, for instance, when wood is treated with creosote, which fills up the pores and keeps out water, and is also a powerful antiseptic.—*Government Bulletin.*

COMPRESSED AIR PUMPS SEWAGE

Pumping of sewage is required in many cities, either for the entire service or for sections which lie lower than any possible outlet which would permit flow by gravity. In many cities also which discharge into large rivers the occurrence of freshets makes pumping necessary. All the familiar devices for raising water are employed, the choice being determined by various circumstances. The Municipal Journal and Engineer has recently given a brief sketch of the sewage pumping arrangements of some thirty cities from New England to the Pacific Coast.

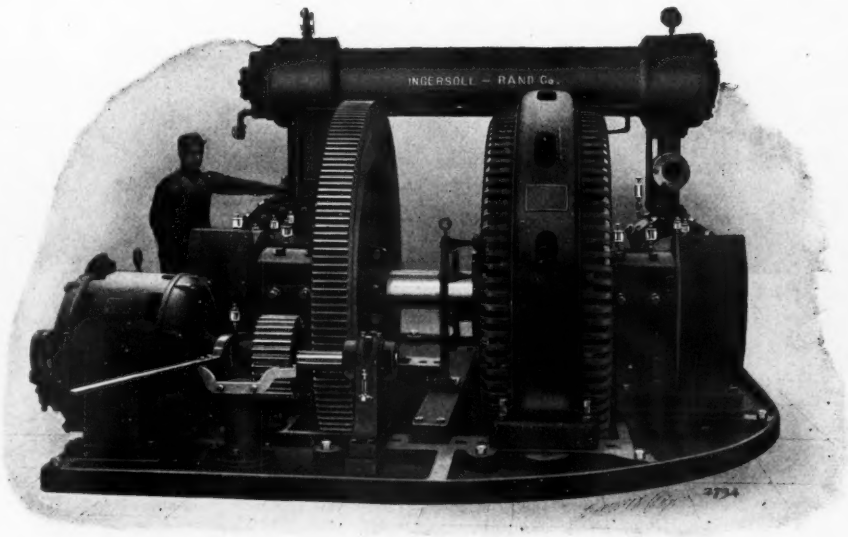
Centrifugal pumps seem to be the favorite, then plunger pumps, and compressed air also has employment. Newark, N. J., for a part of its sewage system is constructing a small pumping station, with a capacity of 500,000 gallons per day, which is to be operated by compressed air.

The Plainfield, N. J., pumping outfit consists of two 10x6 Ingersoll-Rand Class E, air compressors; two 7½-horsepower Wagner motors, equipped with Cutler-Hammer automatic stopping and starting device with a float switch which operates to start and stop the compressor according to the level of the sewage in the stand pipe; one Fairbanks gasoline engine for operating the compressor in case of failure of the electric current; a 42-inch by 8-foot air receiver, and two Duplex displacement pumps or ejectors constructed by the Latta & Martin Pump Company, of Hickory, N. C., operated by air supplied by the air compressors to the air receiver. One-half of the plant is operated at a time, and when so used it has a capacity of 277 gallons per minute. The pumps are placed in a concrete well 13 feet in diameter; the cylinders composing the pumps being entirely below the level of the sewer, and the air being shifted from one pump to the other by means of buckets within the cylinders, operating by the difference in weight of the bucket in the empty cylinder and

that in the full one, these buckets operating a sort of walking beam which, in turn, operates the valve cylinders. Pipes and valves are provided for blowing the sewage from either pair of cylinders back into the sewer when it is desired to open the cylinders for examination or repair. The sewage is pumped through a force main 2,500 feet long, against a static head of 15 feet and a dynamic head of about 20 feet. The plant is visited twice a day and operates automatically without attention during the remainder of the time.

air compressor, this machine lends itself especially well for the use of synchronous motors when placed on electric lines for the purpose of raising their power factor.

An instance of this is at Dos Estrellas mines of El Oro Mining and Development Company, in Mexico. Here there are two 200-horsepower direct-connected air compressors with synchronous motors operating on the Necaxa power line. The synchronous motors on these units are started by an auxiliary 50-horsepower slip-ring induction motor, by means of slid-



WESTINGHOUSE SYNCHRONOUS MOTOR DRIVING INGERSOLL-SERGEANT AIR COMPRESSOR EQUIPPED WITH AUXILIARY SLIP-RING INDUCTION STARTING MOTOR.

THE SYNCHRONOUS MOTOR FOR AIR COMPRESSORS

The slip-ring induction motor is used where frequent starting and high starting torque are required. It lends itself particularly well for elevators and hoists and also for pumps and air compressors if automatic starting and stopping control are required.

The synchronous motor is often used on large units where infrequent starting and high power factor are wanted. There are many power companies which strongly advocate the use of synchronous motors wherever possible, so as not to further reduce the power factor of their existing line and in many cases to improve the existing power factor. Owing to the almost uniform character of the load of an ing gears. The half tone illustrates one of these units. Another instance of this is in the United States navy yard, at Norfolk, Va., where there are two 550-horsepower direct-connected air compressors with synchronous motors of the self-starting type, being installed. In both these instance, the synchronous motors are being used directly to improve the power factor of the existing power lines and thus increase the capacity of the generating station and the transmitting wires.—*S. B. Redfield in American Machinist.*

Of widespread interest, especially to American manufacturers, is the announcement that in future Japan will admit all foreign mining machinery free of duty.

PORTABLE OXYGEN IN A MINE RESCUE*

By Dr. James Robertson.

Pretoria Pit, situated about one mile from Clackmannan, is worked in two seams—an upper seam, 35 fathoms deep, and a lower seam, 40 fathoms. The gradient is 1 in 5. The pit is surrounded on all sides by old workings, containing water and foul air. Three-quarters of a mile to the west of the pit is a large unused quarry, covering several acres of ground, and about 40 ft. deep, full of water; an old pit shaft opens into this quarry. The water suddenly broke into the lower seam. After the flooding was complete the whole amount of air in the lower seam would be about 20,000 cubic feet, coming from all the various passages and openings of every description. All the men except five escaped. Three of these were in the rise of one road, two were locked up in another. The three had about 70 yards of road to creep about in. The two were locked up in a space 2 ft. 6 in. high, 3 ft. broad, and 18 in. from tail of water to coal face. They were sitting with their backs against the coal face and their feet in the water. The men were discovered in the usual way. They scored the roof with a stone, and the sound was heard by the search party in the upper seam. After ten hours' working with pumps it was found impossible to gain on the water, and it was decided to sink a dumb shaft from the upper to the lower seam, near the point where the men were heard knocking. Before starting the dumb shaft, a 3 in. borehole was rapidly put down, when it was discovered that there were only three men here—a father and two sons. Another search was made, when the other two men were located—a father and son. The three men were fed and kept supplied with candles through the borehole until rescued. The pit chart showed the other two men to be in such a perilous position that nothing could be done from the upper seam to save them.

When the pit was suddenly flooded, on February 3, 1906, at about 9.30 a. m., the section where the men were entombed was completely isolated by water, and they were left in an island of air, which was compressed by the sudden roofing of the water. This section was a main road with several side roads leading from it, the average height being about 2 ft. 9 in., the breadth about 5 ft., and the length about 70 yards. The contained air of this main road and the side roads was estimated at 20,000 cubic feet. The five men were breathing this air for four days, three of them also having a light burning, and thus causing an alteration of the compotent parts of the air, diminishing the oxygen and increasing the percentage of CO_2. The other two men were in darkness. On February 6, at 8 p. m., when the sinking of the dumb shaft was completed, the compression was relieved, and exhalation at once began until air equilibrium was established. This exhalation of air diminished the amount of air in the lower seam. After the three men were removed, twenty men now went down the shaft, and proceeded to effect communication with the remaining two men still entombed. In about three hours a stage was reached at which lights would not burn, and breathing was only possible with difficulty; work had to be suspended, and the rescuers were left in darkness. An interesting question here arises: (1) What is the lowest percentage of oxygen compatible with conscious life? (2) What percentage of CO_2 gas may be mixed with air and yet conscious life be supported, and for how long?

At this stage, which was midnight February 6-7, about 40 cubic feet of oxygen was liberated at a point about 150 yards from the dumb shaft, and several feet from the two imprisoned men. This so altered the air conditions that lights were got to burn, breathing became easy, and work, which had been suspended, again commenced. The oxygen supply was kept up as required until 4 a. m., when we all arrived at the upper seam.

During February 4, 5, and 6, while the dumb shaft was being sunk, and before the complete penetration of the rock strata, the air was confined and compressed between the tail of the water in the various roads on the one side and the coal face on the other. The tail of water was a movable, the coal face a fixed, quantity. The water chests, proceeding up and down the shafts, impinging against the water in the shaft before filling, and lifting each time about 1 ton of water to the surface,

*From a paper before the Stirling branch of the British Medical Association.

set up a movement along the water throughout the pit, thereby causing for each impingement a tidal move at the tail; this tidal movement communicated itself to the confined air at various points surrounding the places of entombment, and thereby kept the air in motion, causing a continuous mixing and aiding ordinary physical diffusion, thus preventstagnation of CO_2 gas produced by the breathing and lights.

On the evening of February 6, when the shaft was sunk, compression was relieved, exhalation took place, and, although chesting was continued, the movements now communicated from the water to the air became less effective, as all air movement at once tended towards the point of least resistance—the dumb shaft. It follows (1) that as the dumb shaft was a funnel from the lower the twenty rescuers in the lower seam were consuming and burning the air oxygen, and seam to the upper, and the only opening, no air could be sent down that shaft; (2) that ly two miles, so that it can be dredged and liberating CO_2 gas at a point about 150 yards away from the dumb shaft. The CO_2 gas rapidly increased, and any movement communicated from the water to the air simply mixed a highly poisoned air with a less poisoned air, as no fresh air could gain entrance; during this time also the water level was lowering, and there is no doubt that CO_2 gas, or blackdamp, was creeping on us from some old workings. At this stage, when lights went out owing to CO_2 gas, it mattered little whether water chests impinged on water or not, as all the confined air was highly charged with CO_2 gas, and all air movement was towards the dumb shaft.

The only thing now was to liberate oxygen as near as possible to the imprisoned men; a displacement of gases followed, and a diffusion of oxygen through the poisonous air; the oxygen effect beginning at the point of liberation, and gradually working its way backwards to the dumb shaft. This is what I expected, and what happened. During this final stage the rescuers were in an atmosphere CO_2 gas in which no lights would burn for about fifteen minutes.

PROOF OF OXYGEN TRAVEL.

When proceeding down with the oxygen from the dumb shaft, the first few yards of our journey lights burned; as we went in they gradually lessened, and finally went out; about 80 yards in we passed some of the rescue party scattered and sitting in darkness; we proceeded about 60 yards in advance of them, and then gradually liberated the oxygen. The lights were soon set burning at the point of liberation, and some time afterwards the party of men we passed also got their lights to burn; and in both places lights burned until we all arrived safely at the upper seam.

Here let me add that acetylene gas will burn in a percentage of CO_2 gas with air in which an oil wick light will not. Whether this fact has been proved by former experiments or not, I cannot say, but it was so in this case.

On the afternoon of February 7 I again went down the pit, and found the air in the lower seam so foul and charged with CO_2 gas that no light would burn, even in the dumb shaft, and descent was impossible. On February 10 the water was reduced to the level of the roads, thereby allowing an air current which cleared away the island of CO_2 gas, and I traveled over that section of the pit with safety and with lights.

These facts prove also my statement that no air could have entered the section where the rescue party were working unless a borehole or other opening had been made as stated.

They also show the dangers we all passed through, and establish for all time the value of oxygen in all such cases. Had oxygen not been used, the two men would have lost their lives.

A German patent has been taken out for a linoleum substitute. A fatty oil is heated for a short time and is then vulcanized by treatment with a molten mixture of resin and sulphur, air being blown into the mass during the operation. The vulcanized oil, before it sets, is then distributed in a fine state of division over the fabric which is to form the foundation of the material. If a specially hard material is desired, small quantities of a vulcanizing agent, capable of being spread or finely divided, e.g., sulphur chloride, are mixed with the vulcanized oil as it is being distributed over the fabric, and the material is subsequently passed between heated rollers.

THE PANAMA CANAL

A correspondent of *Engineering-Contracting*, Mr. Warren Wood, writes as follows:

I will give a brief description of the canal as I saw it and as truthful as I can remember: Around Colon every where are to be seen the activities of the Americans, but no great problems are to be solved here. Coming to the Gatun Dam, this bone of contention, such as underground lake, 500 ft. of mud, stratified rock, etc.; this great fill which is going to make the dam is going to be so large and contain so much material that its very weight will be the means of suffocating the underground lake, squeezing the mud out of existence, holding down the stratified rock, and make every liar that has seen "the dam going out into the sea" sneak into his hole and pull the hole in after him.

The great dam will be about a mile long, a half-mile wide at the bottom and about an eighth mile wide at the top; a young mountain thrown into a valley that the Chagres River will never move. When the dam is finished, and the waters of the Chagres River are held back there will be no sudden rise of the river as there is now, caused by the heavy rains and creating a terrible force of water. After the dam is finished it will be like pouring water into an immense tub and letting it run out of the other side over the spillway and thereby losing its force. When this artificial lake is formed it will reach to Bas Obispo, and from there starts the Herculean feat of cutting through a mountain, Gold Hill being the highest cut, from the bed of the canal to the top it being nearly 900 ft. From Bas Obispo to Paraiso is the greatest excavating, the rock is of such a nature in a great many places that it requires drilling and blasting, but the largest amount is taken out by the Giant steam shovels, as, with but two or three exceptions, the whole Isthmus is volcanic ash, compressed and of such a nature that it breaks and slides.

The average person's conception of the canal is a cut through the mountain, like a canyon of the West, but in reality it is a ditch at an angle so sloping that the earth cannot of its own weight slide toward the center. Standing on the top, at Empire, it seems almost impossible that human beings ever dug through such a mountain. On the Pacific side, walls have practically been extended to an island for near-made deep enough without its filling in from the action of the waters. The same length and height of locks is required on the Pacific side as on the Atlantic. The rock for the Gatun dam is taken from Porto Bello, eighteen miles down the coast from Colon, and is as fine a quality as the Staten Island or Princeton trap rock and will withstand the elements for a thousand years.

I will predict that Panama City and along the canal from Bas Obispo to Paraiso will be the favorite summer resort for thousands of Americans during February and March after the canal is finished. In conclusion, I will say the canal is being put through by the best methods, and by as skilled and competent a lot of men as was ever my good fortune to meet. Their hospitality and kindness to a stranger in a strange land will never be forgotten.

GLOSSARY OF AVIATION

The following list of words is proposed by *Patent Progress.*

AVIATION—The science or art of flying.

AVIO—A non-gas-using air vehicle.

AVIATOR—The driver of an avio.

AEROSTAT—A free balloon without propulsive power.

AERONAUT—A balloon having propulsive power, commonly called a "dirigible balloon."

AERODROME—The enclosure in or from which ascensions or flights are made.

AERONAUT—One who navigates the air.

AEROCURVE—(Usually called aeroplane). A thin substantially horizontal, substantially immovable surface which supports the avio as it is propelled through the air.

MONOPLANE—An avio with but one horizontal aerocurve.

BIPLANE—An avio with but two horizontal aerocurves.

POLYPLANE—An avio with a plurality of aerocurves, usually more than two.

HELICOPTER—An avio which is raised and supported in the air by substantially horizontal rotating screws.

ORTHOPTER—An avio with wings that flap as do those of a bird, dragon-fly or beetle.

STATEOSCOPE—A delicate instrument which indicates whether a balloon is rising or falling.

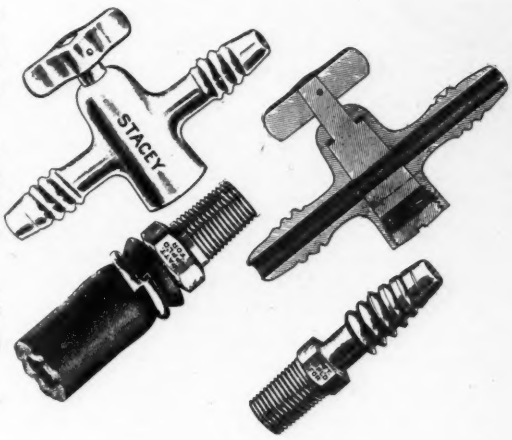
VALVE-CORD—A cord or rope by pulling on which from the basket the valve in the top of the balloon is opened so as to allow the gas to escape and the balloon to descend.

RIP-CORD—A cord or rope sewn into the fabric of a balloon by pulling on which a large rent is made in the balloon so as to permit of the quick escape of the gas; necessarily used in making a landing in a strong wind.

BAROMETER—An instrument which shows the ascensional height by constantly indicating the changes in air-pressure due to increase or decrease of altitude as the avio or balloon goes up or down.

ANEMOMETER—A small wind wheel, operated by the wind; by its use the velocity of the wind being known, the distance traveled and speed attained can easily be computed.

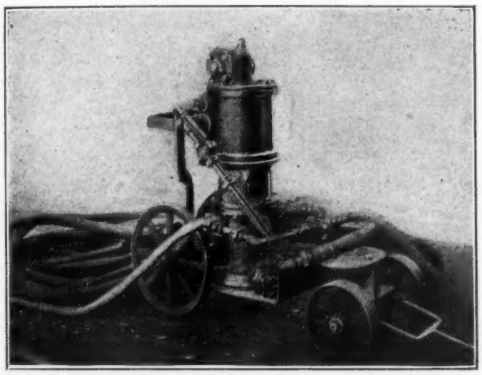
HYGROMETER—An instrument which indicates the percentage of moisture in the air.



PNEUMATIC STOP COCK AND HOSE NIPPLE

The cut herewith shows a pneumatic stop-cock and a steel nipple for use with air hose for rock drills, pneumatic tools, etc., and they both speak for themselves as to their points of excellence. This steel nipple is claimed to be the only one manufactured which can be used on any ordinary tool hose without wire fasteners or hose bands, on account of the forming of a vacuum and forcing the hose to lock of itself upon the nipple. It screws in easily, with a left hand thread, so that the hose will not be disturbed when unscrewing a pneumatic tool, and the insertion of the nipple will not injure the hose. On old or much worn hose a spring is used as shown, this being furnished with the nipple. One end of the nipple has the standard pipe thread.

The stop-cock has a right hand thread on one end and a left hand thread on the other so that it can be inserted and screwed entirely into two hose ends without turning the hose. The springs, when required, can of course be used here as well as upon the nipple. The plug is held to its bearing by a spring which gives the required pressure to keep it always tight. The surfaces of the plug at each end are sufficient to preclude all possibility of leakage and ensure very slow wear. The plug is oiled sufficiently each time the cock is opened to secure unfailing lubrication. Both the articles here mentioned are manufactured by the Harrison Supply Company ,Boston.



A PORTABLE LOCOMOTIVE BOILER TESTER

A very convenient apparatus for testing locomotive boilers is in use in the Fort Wayne shops of the Pennsylvania Railroad. The device consists of a powerful water pump operated by air, which is mounted on a truck as shown in the illustration. This machine, together with the necessary hose, is easily moved to wherever it is needed; the air hose is then connected with the regular shop air supply and the water suction hose with the water supply. The discharge end of the water hose is coupled to the inlet valve on the boiler. The pump is then started and the cold water pressure run up to the desired point. After the test is over, the air and water hose are coiled around the pump cylinders and the machine is moved out of the way until it is again wanted.—*Machinery.*

PNEUMATIC DISPACTH TUBE

The pneumatic dispatch tubes used on the Pennsylvania railroad between the inspection pits and the roundhouse foreman's office, for the purpose of quickly forwarding inspection reports, were thus described by Mr. William Elmer, master mechanic on that road at Pittsburg.

The dispatch tube is made of 2-in. pipe laid in a box underground or carried on the ends of ties; corners are turned with easy curves. The fins are smoothed off the inside of the pipe and a simple carrier can be made of an old air brake hose. When the inspection reports are ready they are slipped into the carrier and the latter pushed into the open end of the tube. A hinged flap valve is then held against the tube and the air pressure turned on, a distance of several hundred feet can be traversed in a few seconds. As almost all our large engine houses are provided with air compressors, it is easy to secure the air pressure needed by using a reducing valve set to a few pounds. The carriers as they come out of the tube strike against a spring buffer a foot or so away and drop into a basket. The man at the receiving end then signals to the other end by means of a bell or incadescent lamp and the air is shut off and the flap valve allowed to fall.

LUMINOUS PROJECTILES

The elaboration of the warship continues without intermission. It is proposed to supplement searchlights with guns firing projectiles which will emit intense lights, either during their flight or on striking the water. For the latter service calcium carbide is the most suitable. The latest form of carbide bomb comprises two cylindrical wooden shells, which telescope together. The inner shell is filled with calcium carbide, calcium phosphide, and gunpowder, not mixed together. It has an iron head and, at its opposite end, an orifice for the escape of gas. The two wooden cylinders separate immediately on leaving the muzzle of the gun and the inner cylinder continues its flight alone. On striking the water the projectile, after the first plunge, rises to the surface. Water enters the shell and evolves acetylene from the carbide, and hydrogen phosphide or phosphureted hydrogen from the calcium phosphide. The hydrogen phosphide ignites spontaneously on contact with the air and sets fire to the acetylene. The flame is not extinguished, but rather brightened, by contact with water, so that an intense light is produced even in a high sea. An intensity of 2,000 candles and a life of three hours are claimed for these acetylene bombs, and they can be projected to distances of two miles or more.

A WIDOW WITH A PROPOSITION

We have great admiration for the prospector and the splendid work he has done, and we never have, where possible, failed him. And surely now, when the call comes from one of the gentler sex, who says she is a widow, but not a "merry widow," nor a romance seeker, nor a husband hunter, but just a young, strong, ambitious woman—a prospector, we feel impelled to extend what aid we may. Tiring of "grub-staking" common man, who brought forth no results, she started out herself and braved the terrors of the desert, accepting the lot of the prospector, with its privations, its heat and cold, its thousand and one things that tax the courage of the bravest. Despite all these she persevered and finally "struck it rich." She writes that she is not soliciting any pastime correspondence but with a strictly business motive offers a half interest in her discovery to any right-minded man who will incorporate and finance her property. We believe that there is some masculine heart yearning to demonstrate beyond peradventure that the age of chivalry is not dead, who stands ready to aid this widow, who is not a "merry widow," but just a brave and ambitious woman prospector.—*Mining World,* Chicago.

Aluminum paint is made by blowing air or gas through molten aluminum while it is setting and at the same time stirring violently. This forms a spongy or granulated metal that is easily pulverized.

There is a difference between benzene and benzine; the former, the more correct name for which is benzole, is a definite chemical compound having a moleculor formula C6 H6 and mostly obtained from coal tar by fractional distillation, while benzine is the name given to one of the volatile products obtained in the refining of crude petroleum.

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EVERYTHING PNEUMATIC

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NEW YORK STATE BARGE CANAL

It would seem that this great work is receiving far less than its share of attention and appreciation. Here is an enterprise second only to the Panama Canal in magnitude and importance. This canal is being constructed from the Hudson River to Lake Erie to take boats 300 ft. long, 40 ft. beam, and 10 ft. draft, capable of carrying a cargo of 2,500 tons. The present canal accommodates barges 78 ft. long, 17½ ft. beam, 6 ft. draft, carrying 240 tons. The original Erie Canal, opened in 1825, took boats 61 ft. long, 7 ft. beam, 3½ ft. draft, carrying 30 tons or 1,000 bushels of wheat.

No portion of the old canal is used from the Hudson at Troy to Rome. The channel of the Mohawk is used most of this way, it being improved by means of a Poiree needle and twelve dams. From Rome the route includes Wood and Fish creeks, Oneida Lake, the Oneida, Seneca and Clyde rivers, a part of Ganargura Creek, and across various streams to Rochester; thence by enlarging the present canal to Buffalo. The Champlain and Oswego canals are to be enlarged at the same time. The canal sections will have a width of 75 feet at the bottom and 123 feet at the water level, and the water depth of all sections is to be 12 feet, sufficient for barges of 2,000 tons.

The total length of the new canals will be 442 miles, of which 407 miles will be contract work. Up to February 1 of this year contracts amounting to $35,771,815 have been let and are under way, slightly more than one-third of the total estimated expenditure. The total excavation to the date named was 15,381,627 cubic yards, and the total concrete placed 424,157 cubic yards.

Contract 12, from Brewerton to Fox Ridge, near Syracuse, a distance of 43.7 miles, is the largest contract yet placed. It includes the excavation of about 7,090,000 cubic yards, including 1,100,000 cubic yards of solid rock and the placing of 29,000 cubic yards of concrete. The contractors are the Stewart-Kerbaugh-Shanley Company of New York City. Steam shovels and side dump cars are used for earth and rock excavation; Page scraper buckets on the levees; orange peel buckets and dipper dredges for subaqueous rock; hydraulic and ladder dredges for soft material under water; drill boats; well and rock drills

for blast holes, representing an investment of about $900,000.

The contract runs from a point in Oneida Lake to its outlet in the Oneida River and down the latter to the Brewerton cut and then across the land to cut off a bend in the river. Soft muck and sand were expected in the river, and for this section a hydraulic dredge built by the Bucyrus Company and two ladder dredges were employed. A hard, cemented gravel was found, the dredges were kept at the work and went through the material successfully, the hydraulic dredge excavating a maximum of 135,000 cubic yards a month. From July 7, 1908, to December 1, 1908, it excavated 447,000 cubic yards, working three 8-hour shifts per day. The material from the pipe line must be discharged behind the dikes and levees to prevent its moving back into the channel.

AMERICAN SOCIETY OF ENGINEERING CONTRACTORS

A permanent organization of this society was effected on April 15, at the United Engineering Society Building, New York. The officers for the first year are as follows: Geo. W. Jackson, of Chicago, President; Halbert P. Gillette, of New York, First Vice-President; D. E. Baxter, of New York, Second Vice-President, and Daniel J. Hauer, of New York, Secretary.

This new national society begins its career with nearly 1,500 members. Corporate members must be engineers, contractors or manufacturers of engineering materials or equipment who have been engaged in these lines for at least 7 years; a degree from a college of standing counting as two years of experience. Applications for membership may be made to the Secretary, at his office 721 Park Row Building, New York.

A LAST WORD ON LEAKY DISCHARGE VALVES

The following note, which sufficiently explains itself, appeared in a recent issue of *Power and the Engineer*:

Mr. W. E. Turner says that he "can hardly agree" with me that leaky discharge valves in air compressors are not a cause of abnormal heating of the air, and consequently of explosions which occur in compressed-air pipes.

Mr. Turner says: "If on account of leaky discharge valves the intake, or suction valve on that end does not lift, is it not an evident fact that as the piston moves back and forth there is a continual displacement, or churning, of air going on?"

In that case the compressor ceases to be a compressor. If it heats the air it does not deliver it, or send it along into the discharge pipe. In an indicator card from an air compressor in normal condition, when the return stroke begins, the re-expansion line drops to atmospheric pressure very quickly, and for the intake stroke the line is slightly below the atmosphere, showing that the cylinder fills with free air to be compressed and delivered upon the next stroke, and yet we know that explosions occur with compressors which thus indisputably take in and deliver nearly a cylinderful of air for each stroke.

Mr. Turner should submit some indicator cards from the alleged compressors in which the intake valves cannot and do not open, as he assumes, on account of the freaks of the discharge valves. I am not clear as to how the same air can remain and play back and forth in the cylinder and become intensively overheated and at the same time be flowing along the discharge pipe.

FRANK RICHARDS.

RAPID MINE DEVELOPMENT ON THE RAND

Some very rapid development has been carried out in the Van Dyck mine. It may be recalled that during November last 323 feet were made in 62 shifts of 9½ hours each by two miners working on the 5th level east, No. 1 shaft. One white man and five natives worked each shift, using two Ingersoll-Sergeant drills. In December an average rate of footage per face of 217.36 feet was attained. During 1908 the total footage driven, sunk and risen in the Van Dyke property came to 10,216.5 feet, in addition to which 721 feet were done on account of the Apex Mines, Ltd. (Gold Section), making a grand total for the year of 10,937.5 feet. Of the total footage in the Van Dyke mine proper, 8,334.5 feet were in respect of drives and 733.5 feet in the incline shaft.—*South African Mining Journal.*

TRADE PUBLICATIONS

SMOKE BOX SUPERHEATER, FEED WATER HEATER, Record No. 66, Baldwin Locomotive Works, Philadelphia, 32 pages and cover, 6 by 9 inches. Various typical locomotives are shown and described embodying these improvements. Text mostly reprinted from *Railroad Age Gazette.*

VALUABLE GRAPHITE PRODUCTS, Joseph Dixon Crucible Co., Jersey City, N. J., 24 pages and cover, 3½ by 6¼ inches. Graphite in various styles for lubrication, pencils and crayons, crucibles, stove cement, belt dressing, graphite brushes, are the products treated of.

CAMERON CONDENSING APPARATUS, Cameron Steam Pump Works, New York. The special adaptabilities of centrifugal condensers, barometric jet condensers, and surface condensers are treated of with the operating pumps and other appurtenances.

THE ST. JOHN INDICATING AND RECORDING AIR-METER, by G. C. St. John, 140 Cedar St. New York. 28 pages and cover 6¼ by 9¼ inches. The instrument described in the pamphlet measures and makes permanent record of the quantity of free air or gas flowing through it at whatever pressure. The principle upon which it operates is that with a uniform difference of pressure on two sides of an orifice through which air is flowing, and a constant initial pressure and temperature, the quantity of air passing bears a direct relation to the size of the orifice.

MINE EXPLOSIONS: THEIR CAUSE AND PREVENTION*

Notwithstanding the advancement made and knowledge gained, scientifically, technically and practically, by experience and costly exhaustive investigation and experiments in past ages, we seem to get no nearer the solution of the great problem of devising means to prevent those lamentable and too frequent occurrences.

Recently, whenever we hear of a mine explosion, the report is either accompanied with the statement, or the statement soon follows, that the mine where it occurred was a "model mine," and that "no cause could be assigned for the explosion."

A "model mine" too often consists of an outward or surface display of fine, costly machinery and other equipments and supplies; in many instances more than necessary to enable those in charge of the mine to operate it in a manner that will protect the employes from all seen, and most unseen, dangers from mine explosions. When companies are willing to provide everything necessary to care for and protect the lives of their employes, and their property, and hire what are considered competent men to take charge, it is a grave reflection on some one that such calamities should occur.

Another feature in connection with mine explosions is that there are always a number of people ready to impress upon the public the idea that such calamities are unavoidable, and their cause of mystery beyond human skill to explain. There is no mystery about the cause of explosions in mines, and no logic in the argument that they are unavoidable. They are the result of accumulations of carburetted hydrogen gas and coal dust, in most instances the former being set in motion by contact with flame, and the explosion being increased and intensified by the ignition and explosion of the dust, to the extent of the amount of the accumulation and the fixed carbon and volatile combustible matter contained in it.

The higher the carbon in coal dust, the more intense the heat, the greater the expansion of flame, and the more destructive the force.

Gas accumulates in mines from defective ventilation, the air current not being conducted to the interior of the mine on account of bad doors, leaky stoppings, blocked airways, or ventilating fans being stopped while the mines are in operation, as per the evidence adduced before the coroner's inquiry in the Marianna explosion in Pennsylvania last December.

If the ventilating fan is capable of producing the necessary current of air, and the ventilation in the mine is cared for as it ought to be, there can be no danger from accumulations of gas.

If coal dust is sprinkled when necessary, and removed from the mine as it should be, and not allowed to be thrown back on the gob

---

*Abstract of address to Mining Students, Ohio State University, by George Harrison, Chief Inspector of Mines.

piles, or used for ballast on the haulways (as it is in many instances), there can be no danger from accumulations of coal dust.

If coal is properly undercut and prepared before blasting, and the drill holes drilled and power gauged with practical skill and good judgment, as they should be, there can be no fear of danger from blown-out shots.

Mine explosions are liable to occur at any season of the year, and under all weather conditions, but they more frequently occur in the winter season, during sudden changes of weather, especially with a low barometer, or rising thermometer, or both.

ATMOSPHERIC CHANGES AS AN INDEX.

Before safety lamps and ventilating fans became in general use in mines, old miners were very diligent in their observations of atmospheric changes, the theory being that a high atmospheric pressure had a tendency to press the gas back in the strata in mines and reduce the flow for a time below the normal amount generated; but, just as steam rushes from a steam boiler when the weight on the safety valve is reduced, as soon as the barometer began to fall, and the pressure was relieved, the extra amount of gas pent up by the heavy pressure suddenly flowed from the joints and fissures in the coal and roof, and the furnace power was so affected by the reduced pressure, and probably also by a rise in the temperature at the same time, that the air current was diminished and inadequate to dilute the extra flow of gas, thus permitting gas to accumulate and increase the liability of an explosion.

The adoption of fan ventilation in mines is a great improvement over the old system of furnace ventilation, and is well calculated to overcome the effect of sudden changing weather conditions on the ventilation and safety or danger in the operation of mines, especially mines generating dangerous quantities of fire-damp.

If a barometer and thermometer were placed at every mine, and closely observed, particularly in the winter season, by the engineer who has charge of the ventilating fan, and the speed of the fan increased or reduced as weather conditions indicated it should be, the general public would not be so often horrified by the unnecessary destruction of human life in the mines.

A safety lamp, unless its properties and uses, and the danger of tampering with it, are generally understood, is like the insulation on a highly charged electric wire in a mine; it is a danger in disguise. Sir Humphrey Davy and others conferred a great boon on the mining communities in foreign countries when they invented and perfected the safety lamp for use in gaseous mines, but in some respects the lamps have been an additional danger, and through their misuse, thousands of miners have been launched into eternity without a moment's warning, which ought not to have been if too much dependence had not been placed on the safety lamp, and too little attention given to the unnecessary accumulation of large and dangerous volumes of fire-damp.

THE USE OF SAFETY LAMPS.

Safety lamps can and may be used to great advantage in leading headings in gas-producing mines, especially where such places are raising rapidly and it is difficult to conduct a large volume of air to dilute and render harmless such gases, or in crossing clay veins or faults where feeders of gas are usually encountered; and even in such cases they should be placed in the hands of men selected for their good judgment, experience and carefulness. To introduce them in a general way in placing them in the hands of a very large majority of men, especially in this country, who know nothing of their properties or uses, and placing the lives of every employe in the mine in the hands of every individual who enters it, and it ought not to be done without the most careful and serious consideration, and that only when the flow of gas is so great that it cannot be reached and dispersed by a volume of air.

An adequate, and never-ceasing volume of pure air conducted throughout the interior excavations of a mine, and the prevention of the accumulation of the elements of danger by a strict and constant vigilance on the part of those intrusted with the management, is the safer, less expensive and more satisfactory way of preventing mine catastrophes. Strike at the root, remove the primary cause of mine explosions, and there will be no necessity to search the pockets of the dead miners, after an explosion, to find if they were carrying pipes, smoking-tobacco, and matches, to the mine, as a subterfuge to relieve some one who had neglected an important duty, from grave and serious responsibility.

In a railroad wreck, an investigation usually discloses the fact that it was caused by a neglect of duty; a violation of orders; a broken rail; an open switch, or a defective joint; but in a mine explosion (fortunately for some people), the evidences as to the cause are usually obliterated by the force and destructiveness of the explosion, and the unsuspecting public is advised that such occurrences are unavoidable, and no cause for them can be assigned, when if the truth could be known there is little doubt that there was an "open switch," or in other words, a woeful want of necessary discipline and proper observance and application of law.

THE USE OF ELECTRICTY IN MINES.

Without going into details, let me also impress upon you that the general use of electricity in mines; the use of coal-cutting machinery and high-speed haulage methods, as well as the increase in the number of deep shaft mines, with reckless methods of mining and excessive use of flame-producing explosives, are all factors of danger, that under favorable circumstances and conditions very materially affect the atmosphere of mines, and often-times cause serious and dangerous vibrations of the ventilating current, increasing the liability of mine explosions if the treacherous foe is lurking around, ready at first opportunity to prey upon his unsuspecting victims.

ELECTRICITY AND ELECTRIC MACHINES IN COAL MINING

The following we take from a paper read before the Elizabeth, Pa., Mining School by Mr. Joseph Bennett, a practical miner of the bituminous coal region:

Now, since coal dust and black powder have become so dangerous in coal mining, it has caused a great deal of comment throughout the country as to which should be taken out of the mines—black powder or the machines that are producing so much dust as to make the mines dangerous? To my belief electric chain machines should be taken out of all mines generating explosive gas, for such machines are dangerous. In under-cutting the coal, the chain machine grinds the finest of dust and produces more of it than any other machine that I have ever seen or had experience with in mining coal. The electric chain machine also heats the atmosphere of a mine while the machine is in operation. This brings the dust in such places as give off a small percentage of gas and makes them dangerous. I have seen places where open lights and the electric chain machines were used, when the men running the machine would not put their open lights down near the under-cutting for they knew that it would cause a small explosion. In the same mine compressed air machines were in use previous to the electrical, and while the compressed air machine was under-cutting the coal the open lights were constantly on the bottom —often set under the under-cutting 18 inches— and such a thing as an explosion was not known.

In my opinion compressed air is 90 per cent. safer for mining coal than electricity. The exhaust from the compressed air machine has a cooling effect on the atmosphere of a mine and gives off more or less moisture. The moisture helps to still the dust and keep the atmosphere of the mine at a lower temperature. Now, since black powder has been proven to be such a menace to mining, it should not be used for blasting purposes in coal mines, but should be strictly prohibited; and so should electricity in mines generating explosive gas, for I believe that when one of these dangerous factors of coal mining has to be taken out the other should be taken with it. The laws governing the use of black powder and electricity in coal mines should be Federal laws, and such laws should be put into effect without ifs and ands, for the world has seen within the last two years that black powder, electricity and the dust that is being produced by the electric chain machines have been dangerous.

I am not of the same opinion as an electrician of West Virginia who, a short time since, wrote his opinion concerning electricity in mines. He stated in his writing that he did not believe it right to hurt the mining industry for the sake of saving a few lives. He must remember that a miner's life is just as dear to him as that of any other class of workmen in the world today.

I do not believe the mining industry would be hurt by taking out electricity, for I believe the same production of coal can be taken from mines with other than electric machines and with less danger. The mine laws of the present time, if obeyed, would put electricity down and out in mining coal in the bituminous fields.

NOTES

The 'Ingersoll Rand Company has recently sold an air compressor to supply air, as mentioned in the order, for "putting trousers upon sausages."

The Bowery Mission Free Labor Bureau announces that it is prepared to supply any number of men, for any kind of labor, at a moment's notice. Address John C. Earl, Financial Secretary, 92 Bible House, New York City.

The total number of passengers carried per day by the surface, elevated and subway cars in the entire city of New York is about 3,500,000, while in the Borough of Manhattan alone 6,500,000 are carried up or down by the 8,000 passenger elevators.

The longest pipe line on earth is being constructed by the Cincinnati gas interests in the development of their project to conduct fuel from West Virginia and Kentucky gas fields to Cincinnati. The distance will be from 160 to 200 miles and the pipe will be 18 and 20 inches in diameter.

The Eagle Point Lime Works, Eagle Point, Ia., have further modernized their plant by the installation of a complete system of compressed air for drilling and blasting and other purposes in their quarries. The system works perfectly, and will enable the concern to accomplish about twice as much work as formerly.

Atmospheric pressure is 14.7 lbs. per. sq. in. at sea level; at 1,000 ft. elevation, 14.13 lbs.; at 2,000 ft., 13.58 lbs.; at 3,115 ft., 13.05 lbs.; at 4,169 ft., 12.54 lbs.; at 5,225 ft., 12.0 lbs.; at 6,300 ft., 11.56 lbs.; at 7,300 ft., 11.1 lbs.; at 8,000 ft., 10.8 lbs.; at 10,000 ft., 10.0 lbs.; at 12,000 ft., 9.3 lbs.; at 14,000 ft., 8.6 lbs.

Experiments to determine the relative efficiency of aerial and underground lines for telephone purposes have recently been made at Newcastle, England. Speaking from Newcastle to London (nearly 300 miles) was successfully accomplished with the aerial wire, but with the underground cable the voice became almost inaudible at forty-eight miles.

While sulphuric acid is probably the most important of all chemicals, immense quantities being made yearly, the greater part does not come upon the market; for, being expensive and difficult to ship, consumers of large amounts generally make their own acid.

At Zuber's stone quarry, near Gladsden, Ala., sixteen men were eating their noon meal. Otis Browne, a fat man weighing 260 pounds, had finished his meal and was lying down on his back to sleep. 200 feet above a negro was carrying a 40-pound box of dynamite. The negro slipped and the 40-pound box fell the 200 feet, striking the fat man, Browne, after which it bounced harmless to the ground.

When red hot coke is quenched in cold water the at first somewhat surprising result occurs that three or four times as much water is taken up as is absorbed by the same coke when dipped into hot water. Coke has many pores which remain filled with air or gas even when dipped in water, and with a rise in temperature the gases diminish in density, so that at a bright red heat the real quantity of gas contained is not more than a quarter of what it would be if the coke were cold, and quenching the bright red coke therefore imprisons in the pores only one fourth the quantity of air or gas, allowing three or four times as much water to fill the pores instead.

The great improvements in mining in recent years have made it possible to extract a dollar's worth of gold at about what it cost to get a half-dollar's worth a few years ago. More than this, some of the best paying gold mines here and abroad are working none but ores which twenty years ago could not have been worked at a profit. Mines, as manufacturers of credit for the communities in which they are situated, are blessings to all channels of commerce.

The mean height of all the land now above the sea is about 1000 feet, and the mean depth

of the ocean is at least 12,000 feet. The extreme heights of the land, although probably no less than the extreme depths of the sea yet are exceptional heights, while the ocean maintains its depths over enormous areas. As the surface of the ocean is two and a half times that of the land the ocean would give place to all the land above sea level thirty times over.

Although coal-cutting machines were introduced in Great Britain fifty years ago, in 1902 there were only 166 machines used in that country, while in 1907 there were 1,493. In the United States in the year 1906, there were 10,212 machines in use, and the percentage of the total coal mined by machinery was more than 30 per cent. Each machine used in the United States showed an average anuual production of 11,638 tons, which compares with 8,630 tons in Great Britain.

As Victor Hugo prophesied he would, man has already improved on Nature's work in the field of chemistry, in more ways than one. Calcium carbide, a compound of pulverized limestone and carbon, out of which acetylene gas is made, and carborundum, a compound of quartz sand and carbon, an abrasive second in hardness only to the diamond, which has, to a large extent, driven emery out of the market, are each of them synthetic products of the electric furnace, purely man-discovered and man-made, never yet found on land or sea, in Old Mother Nature's workshop.

In order to test whether or not his apparatus for the prevention of mountain sickness is a success, Prof. David P. Todd will conduct experiments in ballooning. It is Prof. Todd's idea to establish on some lofty peak an astronomical observatory, in the clear atmosphere of which it will be possible to make better astronomical observations than are now obtained. To carry out that idea, he intends first to ascertain whether or not mountain sickness can be be prevented at elevations exceeding 6,000 feet. He has devised a special apparatus for supplying compressed air which he hopes may attain the object.

The explosion of a carbonic acid tank while under considerably less pressure than that for which it was sold by the manufacturers resulted in the death of a man nearby. His administratrix brought suit against the manufacturers. The decision of the court, 154 Fed. Rep. 121, was to the effect that the manufacturer of a thing inherently dangerous, or which becomes dangerous when applied to its intended use, who sells it for such use, is liable in damages to anyone who, without fault on his part, sustains injury which is the natural and proximate result of the manufacturer's negligence.

The irrigation works of the federal government in the western states will include three of the greatest dams in the world. The Shoshone dam, with a height of 326 feet and the extremely short length of 175 feet will store 456,000 acre-feet, 148,975,200,000 gallons; the just completed Pathfinder dam, 215 feet high and 226 feet long, will store 334,-867,500,000 gallons; while the Roosevelt dam, 284 feet high and 1,080 feet long will store 419,482,800,000 gallons. The Assouan dam on the Nile, the most notable structure comparable with these, after the work of increasing its height has been completed, will impound 1,-860,000 acre-feet, or 607,662,000,000 gallons.

For more than 50 years the people of Constantinople have not witnessed a balloon ascent. During the lifetime of the present Sultan's father, Abdul Medjid, an Englishman ascended in a balloon before the eyes of the astonished Turks; but Abdul Hamid saw in the balloon a likely means of dropping bombs down upon the palace of Yildiz, and he forbade any balloons to ascend in or near Constantinople. As such fears have vanished the prohibition has been withdrawn, as the Minister of War has given permission to a Frenchman to inflate his balloon with the aid of Turkish soldiers in the Pera suburb of Constantinople, to the north of the Golden Horn.

Without a visit to a modern fortification or battle-ship and personally witnessing the target practice, one can scarcely comprehend what it all means, so startling have been the developments. For example, projectiles weighing more than 1,000 pounds are now fired at minute intervals from twelve-inch mortars to a height of three or four miles, and a like range, with but twenty-five pounds of smokeless

powder, and with such accuracy as to cause every projectile to fall upon the deck of a battle-ship traveling ten miles per hour. These monstrous elements of destruction (a single shot would sink a ship), are fired from pits absolutely protected from the fire of a warship, and but ten per cent. of the manning details are exposed to danger.

The completion of the Cape Town-Cairo Railway in Africa will give the world its longest railroad. It will connect North and South Africa and will be in the neighborhood of 6,400 miles long. The cost when completed will reach close to $1,000,000,000. Although this is an immense sum it is comparatively small when it is considered what it will be to Africa and in fact to the entire world. It will make it possible for the traveller to journey from Berlin or Paris to Cape Town in ten or eleven days. The country which it will open up is rich in almost everything in the mineral world, such as gold, silver, copper and diamonds. Only 2,500 miles is yet to be completed, which is between Khartum, in the British Egyptian Soudan, and Broken Hill, a point in Rhodesia.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

MAY 4.

920,129. MILKING APPARATUS. EZRA E. GOOD, Waterloo, Iowa.

920,202. AIR-ENGINE. ALBERT E. SMITH, Chicago, Ill.

920,373. AIR-VALVE FOR RADIATORS. WILLIAM P. MCDANIEL, Omaha, Nebr.

920,389. AIR-BRAKE. FRANK B. RAE, New York, N. Y.

920,421. GAS-COMPRESSOR. WILLIAM J. BOLAND, Chicago, Ill.

920,443. AIR-PUMP FOR CARBURETERS. ALEXANDER D. ELLIOTT, Viola, Ill.

920,491. FLUID-PRESSURE CONTROLLER. THOMAS O. PERRY, Chicago, Ill.

920,504. FLUID-PRESSURE BRAKE. WALTER V. TURNER, Wilkinsburg, Pa.

920,584. APPARATUS FOR PURIFYING AIR. KARL KOSAK and RICHARD HERZ, Vienna, Austria-Hungary.

920,631. THROTTLE-VALVE MECHANISM. SAMUEL OLDHAM, Philadelphia, Pa.

920,744. PNEUMATIC ACTION FOR SELF-PLAYING INSTRUMENTS. EMORY C. HISCOCK, Chicago, Ill.

920,788. SELF-TIGHTENING ROCK-DRILL CHUCK. JAMES A. THOMPSON, EDWIN M. MACKIE, and PERCIVAL F. DOYLE, Chicago, Ill.

920,792. WINGED PROPELLING AND GUIDING MECHANISM FOR AIR-SHIPS. JULIUS UHERKOVICH DE UHERKOCZ, Bayonne, N. J.

920,811. PROCESS OF STERILIZING. ARTHUR J. BALDWIN, East Orange, N. J., and JAMES F. LESTER, New York, N. Y.

4. The process of sterilizing substances of the kind described, and preventing the growth or development of bacteria therein, which consists in subjecting such substances to a sustained air pressure.

920,855. AIR-BRUSH. LEONARD FORESTER, Steubenville, Ohio.

MAY 11.

920,997. VACUUM-PAN FOR EVAPORATING APPARATUS. GEORGE R. RAY, Manistee, Mich.

921,010. COMBINED FORCE-PUMP AND SPRAY-TANK. ROSCOE S. SHELDON, West Allis, Wis.

921,019. HOT-AIR HEATING SYSTEM. ROBERT G. SPEER, St. Louis, Mo.

921,040. PNEUMATIC SUCTION-PUMP. DAVID T. WILLIAMS, Paterson, N. J.

921,130. SYRINGE. BENJAMIN F. LOCKWOOD, Frewsburg, N. Y.

1. A receptacle for *fluid under pressure* consisting of an air tight receptacle, and a resilient air tight sack within said receptacle containing air under pressure to eject the fluid from said air-tight receptacle.

921,155. COMPRESSION-PUMP. FRANK G. PEREZ, San Francisco, Cal.

921,164. COMPRESSOR, VACUUM-PUMP, AND THE LIKE. FERDINAND J. ROCHOW, Brooklyn, N. Y.

921,174. PNEUMATIC TIRE. WILLIAM H. SNYDER, Kenton, Ohio.

921,240. VALVE MECHANISM FOR CHANNELING-MACHINES. HARRY V. HAIGHT, Sherbrooke, Quebec, Canada.

921,307. VACUUM DRYING APPARATUS. EMIL W. STROHN, Buffalo, N. Y.

921,341. PNEUMATIC STRAW-STACKER. SIMON M. O. BANGEN, Crookston, Minn.

921,365. HUMIDIFIER. ALFRED R. CLARKSON, Birmingham, Ala.

921,409. COMPRESSED-AIR SPRAYING AND COATING MACHINE. ROBERT M. JOHNSTON, Mansfield, Ohio.

921,420. FLUID-CONTROLLED DRILL-BIT SWAGING AND SHARPENING MACHINE. JOHN G. LEYNER, Denver, Colo.

921,515. MEANS FOR USE WITH BALLOONS AND OTHER AIR VESSELS FOR INDICATING AIR-CURRENTS. CHARLES DAVIS, London, England.

921,632. PORTABLE PNEUMATIC PUMPING APPARATUS. JOHN W. SMITH, Philadelphia, Pa.

921,654. LIQUID-MEASURING APPARATUS. HENRY PEIN, Jersey City, N. J.

1. A measuring device for liquids comprising a receptacle for a liquid, an air tight chamber; means whereby the air may be transmitted from one of said chambers to the other, and a valve adapted to control the passage between the said liquid and air chambers.

MAY 18.

921,669. PNEUMATIC CLEANING APPARATUS. CARL W. E. BOEGEL, Lima, and JAMES C. LEWIS, Mansfield, Ohio.

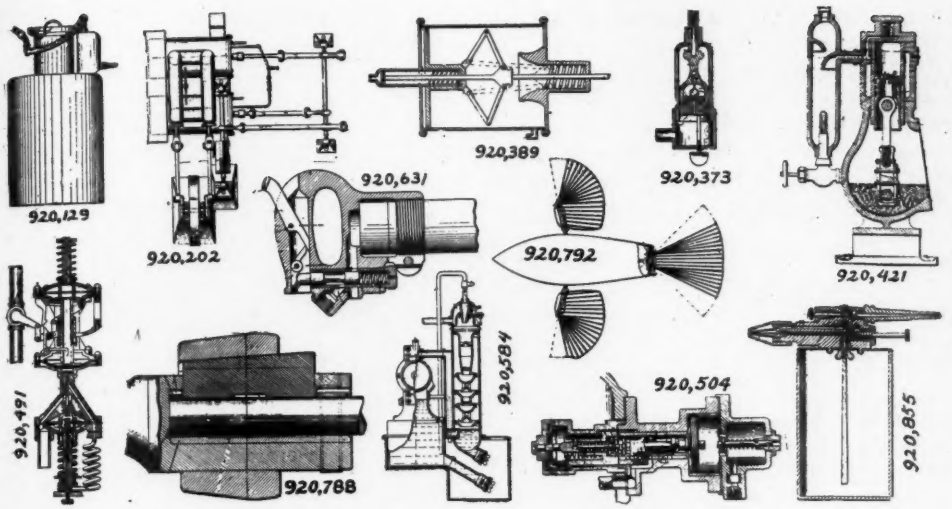
921,710. PNEUMATIC TIRE. GRANT JACOBS, Des Moines, Iowa.

921,764. BLOWER FOR PEAS OR THE LIKE. ALBERT H. WHEELER, Worcester, Mass.

921,793. APPARATUS FOR AUTOMATICALLY STOPPING STEAM AND ELECTRIC TRAINS AND SIGNALING THE ENGINEER IN CHARGE. GEORGE P. BURKE, Louisville, Ky.

921,803. CONTROLLING DEVICE FOR TWO-STAGE COMPRESSORS. RUDOLPH CONRADER, Erie, Pa.

921,890. COMPRESSOR. FRANK A. RIDER, Pittsburg, Pa.



PNEUMATIC PATENTS, MAY 4.

921,915. AIR-SHIP. BEN H. TINGLEY, Hamilton, Wash.

922,135. VALVELESS PNEUMATIC TOOL. FREDERICK S. GRAHAM, Philadelphia, Pa.

922,183. AERATING-MACHINE. HUBERT PEARCE, Stanstead Abbots, England.

922,228. AIR-SHIP. MICHAEL H. WHALEN, New York, N. Y.

922,318. AIR-BRAKE SYSTEM. EDWIN J. NEWTON, Chicago, Ill.

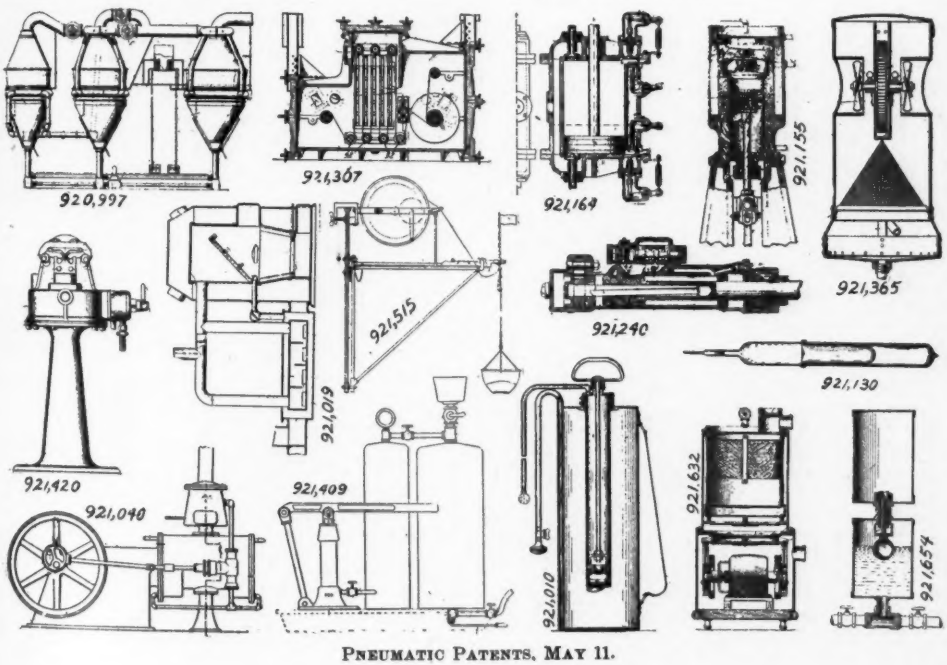
922,342. GLASS-BLOWING MACHINE. HARRY A. SCHNELBACH, Crafton, Pa., and EDWARD J. SCHATZ, Marion, Ind.

922,431. TUNNELING APPARATUS. HENRY JAPP, New York, N. Y.

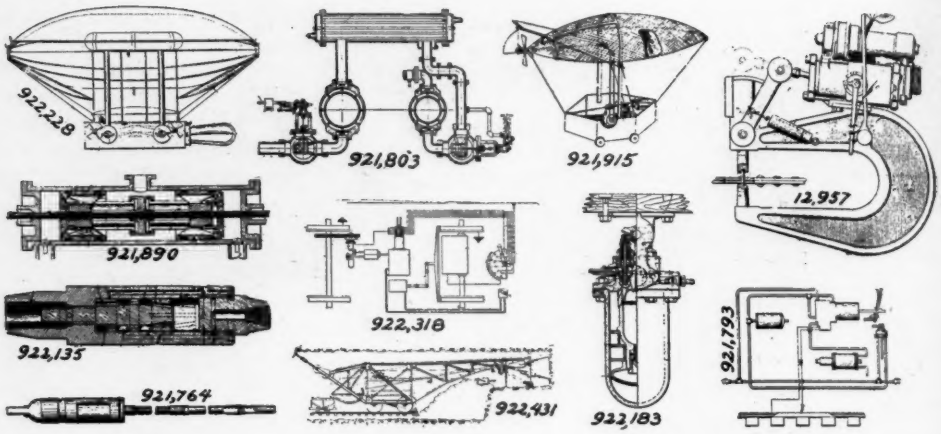
12,957. POWER APPLIANCE. MORRIS C. WHITE and OTHO C. DURYEA, Los Angeles, Cal. (Reissue.)

MAY 25.

922,526. WATER-FEED, DUST-LAYING, ROCK-DRILLING ENGINE. CHARLES H. SHAW, Denver, Colo.



PNEUMATIC PATENTS, MAY 11.



PNEUMATIC PATENTS, MAY 18.

922,531. ELECTRIC AIR HEATING AND DISCHARGING DEVICE. LOUIS A. SIEBERT, Columbus, Ohio.

922,549. AIR-SHIP. SAMUEL D. WHEELER, Chicago, Ill.

922,582. FUMIGATOR. JACOB HAUCK, Denison, Tex.

922,595. AIR PUMP OR CONDENSER. HULDREICH KELLER, Berlin, Germany.

922,603. GAS-EXTRACTOR AND MINE-VENTILATOR. GEORGE LAWS, Philipsburg, Pa.

922,694. AUTOMATIC AIR-COMPRESSOR. JOSEPH GRUNINGER, New York, N. Y.

922,698. SIPHON. WALTON HARRISON, Bloomfield, N. J.

1. The combination of a siphon tube, and a member of resilient material connected therewith and adapted to fit air-tight upon a receptacle, said member being free to undergo distortion for the purpose of destroying its air-tight fit.

922,840. SAWDUST-CATCHING ATTACHMENT FOR CIRCULAR SAWS. DANIEL J. BEMILLER, Butler, Ohio.

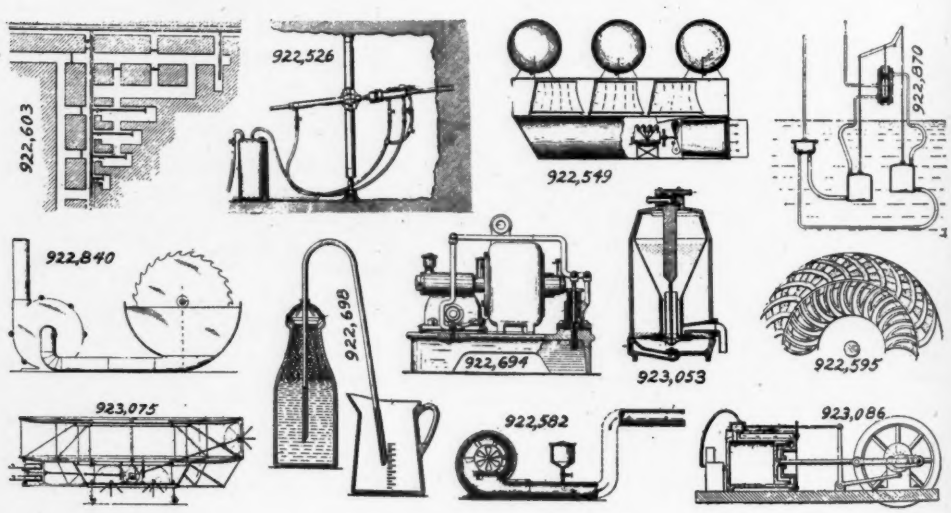
922,870. MEANS FOR RAISING LIQUIDS. HUGO P. W. ESPING, Nassjo, Sweden.

3. In a compressed air liquid pump, a submerged vessel free to rise and fall within the liquid, a counterbalanced lever located above the surface of the liquid and having an arm connected with the submerged vessel and extending upwardly at an angle oblique to the surface of the liquid whereby the leverage of said arm is rapidly shortened during the upward movement of thte vessel, means for admitting compressed air to and discharging it from the vessel and means for discharging the liquid from the vessel.

923,053. HYDRAULIC AIR-PUMP. PERRY LEWIS, Mankato, Minn.

923,075. AEROPLANE. JOHN POTTS, Winchester, Ohio.

923,086. ATMOSPHERIC ENGINE. WILLIAM H. SPEIRS and ANTON HOLM, Paterson, N. J.



PNEUMATIC PATENTS, MAY 25.